Attachment 1

Relevant Authorizations for Coastal Restoration Efforts

1. Caernarvon Freshwater Diversion project (authorized by the Flood Control Act of 1965 (PL 89-298), the WRDA of 1974 (PL 93-251), and WRDA 1986 (PL 99-622)).

2. Davis Pond Freshwater Diversion project (authorized by the Flood Control Act of 1928 (PL 70-391) and the Flood Control Act of 1965 (PL 89-298); the project was further amended by WRDA 1986 (PL 99-622) and WRDA 1996 (PL 104-303)).

3. Section 103 of the 1962 River and Harbor Act - Hurricane and Storm Damage Reduction. Section 103 of the 1962 River and Harbor Act provides authority for the USACE to develop and construct projects to protect the shores of publicly owned property by constructing revetments, groins, and jetties, to include periodic sand replenishment. Each project is limited to a Federal cost of not more than $3 million.

4. Section 1135 of WRDA 1986 - Project Modifications for Improvement to the Environment. Section 1135 of the 1986 WRDA provides authority to restore degraded ecosystems, if the construction or operation of a USACE project contributes to the degradation of the quality of the environment. Measures for restoration through modifications of the structure or operation of the structure can be undertaken. Measures at other locations affected by the construction or operation of the project can also be undertaken if they do not conflict with the authorized project purposes.

5. The Coastal Wetland Planning, Protection and Restoration Act (PL-101-646, Title III), (CWPPRA), enacted in November 1990, provided the first Federal statutory mandate for restoration of Louisiana's coastal wetlands.

6. The Barataria-Terrebonne National Estuary Program (BTNEP) was established in 1990 under the U.S. Environmental Protection Agency 's (USEPA) National Estuary Program. BTNEP established a partnership between the USEPA and the State of Louisiana to study natural and man-made causes of environmental degradation in the Barataria-Terrebonne watershed and to protect the watershed from further degradation.

7. Section 204 of the 1992 WRDA - Ecosystem Restoration Projects in Connection with Dredging. Section 204 of the 1992 WRDA provides authority for the USACE to restore, protect, and create aquatic and wetland habitats in connection with construction or maintenance dredging of an authorized project.

8. Section 206, 1996 WRDA - Aquatic Ecosystems. Section 206, of the 1996 WRDA provides authority for the USACE to restore degraded ecosystems. This authority is similar to Section 1135, but a USACE project need not be a contributor to the degradation of the quality of the environment.

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Attachment 2

Prior Studies, Reports, and Existing Water Projects

Additional information regarding restoration actions with respect to the LCA study authority can be found in the section 1 INTRODUCTION (found on page MR-14).

A number of studies and reports on water resources development in the study area have been prepared by the USACE, other Federal, state, and local agencies, research institutes, and individuals. Previous studies established an extensive database for this study. Historical trends and existing conditions were identified to provide insight into future conditions, help isolate the problems, and identify the most critical areas. Those projects not fully described in section 1 are summarized here.

The more relevant studies, reports, and projects are described as follows:

1. In November 1993, The Louisiana Coastal Wetlands Restoration Plan was prepared, by the Louisiana Coastal Wetlands Conservation and Restoration Task Force as part of the Federal Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) established in 1990 (Public Law 101-646, title III). This plan is a product of communication, coordination, and cooperation among the designated participants from the state and Federal agencies, and through formal and informal involvement of numerous local government agencies, the academic community, private environmental and business groups, and countless motivated individuals. There are two important findings that form the core of the Restoration Plan.

    1. First, by phasing in an adequate investment now, it is technically feasible to significantly slow or reverse coastal wetlands loss and thereby protect, sustain, and increase the most valuable environmental and economic assets of the region.
    2. Second, the no-action alternative condemns the Nation to a far more expensive course of uncoordinated and increasingly futile emergency efforts to protect existing investments in the economic infrastructure without hope of achieving sustainability.

    Under the authority of CWPPRA, the Task Force has actively pursued its mission, fulfilling a second CWPPRA directive of submitting a series of annual Priority Project Lists. CWPPRA projects include gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, and barrier island projects.

2. In 1994, the Governor's Office of Coastal Activities Science Advisory Panel prepared a plan entitled An Environmental –Economic Blueprint for Restoring the Louisiana Coastal Zone: The State Plan for the Wetlands Conservation and Restoration Authority (State Wetlands Authority), constituted under Act 6 (R.S. 49:213.1 et seq.). At about the same time, other plans were developed, as the need for action became widely apparent.

3. In April 1995, a report was presented entitled A White Paper-The State of Louisiana's Policy for Coastal Restoration Activities. This White Paper represents the State of Louisiana's appraisal of the present conditions and the ongoing challenges in the restoration and protection efforts of our state's coastline. Equally important, this paper outlines strategies for a 20-year coastal restoration plan based on a partner-supported, unified plan of action. In this paper, the State calls upon its partners: the USACE, the U.S. Departments of Agriculture, Commerce, and Interior, and the U.S. Environmental Protection Agency, along with other Federal, state/local agencies, user groups, concerned citizens, and private interests to support and endorse the strategies outlined there in. The paper presents the State's desire to improve coordination with all local governments and Federal agencies, as well as our Congressional delegation.

4. The December 1998 report Coast 2050: Toward a Sustainable Coastal Louisiana presents a coast wide plan developed through a joint effort of the CWPPRA Task Force and the State Wetlands Authority. The Coast 2050 plan was subsequently adopted by the State Wetlands Authority as their official plan. The plan combines elements of all previous efforts, along with new initiatives from private citizens, local governments, state and Federal agency personnel, and the scientific community. The plan integrates coastal management and coastal restoration approaches, and adopts a multiple-use approach to restoration planning. Among other contributions, the Coast 2050 Plan provides new quantitative techniques for projecting land loss patterns into the future, a coast wide assessment of subsidence rates and patterns, and a comprehensive consideration of changes in fish and wildlife populations. The Coast 2050 plan establishes regional and coast wide common strategies and programmatic recommendations. The coast wide strategies were updated in January 2001 and include beneficial use of dredged material and dedicated dredging to create, restore, or protect wetlands; herbivory control; stabilization of the width and depth of major navigation channels and other water bodies at their point of intersection; maintenance of gulf, bay, and lake shoreline integrity; management of pump and gravity-flow outfall for wetland benefits; vegetative planting; maintaining, protecting, or restoring coastal ridge function; terracing; off-shore and riverine sand and sediment resources; diversions and riverine discharge; and management of diversion outfall for wetland benefits. Programmatic recommendations include: coordinate wetland mitigation, provide appropriate relocations costs and flood control for impacts related to wetland restoration, expedite coastal restoration permitting, impose and enforce boat wake limits, implement measures to improve wetlands and aquatic habitats, improve land rights acquisition procedures, increase wetlands through incentive based programs, identify funding sources to adequately address coastal land loss problems in Louisiana, prevent negative effects of shell dredging, mitigate water hyacinth problems, minimize losses due to permitted activities, develop and sustain a comprehensive barrier shore/island initiative, and provide for better coordination among agencies regarding coastal issues.

5. In May 1999, a report entitled Section 905(b) (WRDA1986) Analysis Louisiana Coastal Area, Louisiana --Ecosystem Restoration was prepared by USACE. This reconnaissance level effort evaluated the Coast 2050 Plan as a whole and expressed a Federal interest in proceeding to the feasibility phase.

Previous partial responses to the Louisiana Coastal Area Study Authorization of 1967 that have been completed at the present time are summarized as follows:

6. In 1984, a feasibility report entitled Mississippi and Louisiana Estuarine Areas was prepared by USACE. The report recommended the diversion of Mississippi River water into the Lake Pontchartrain Basin and Mississippi Sound to increase habitat conditions and improve fish and wildlife resources. The project was authorized by the Water Resources Development Act of 1988.

7. In September 1984, an initial evaluation study entitled Louisiana Coastal Area Louisiana, Shore and Barrier Island Erosion reports investigative findings which indicate that Louisiana's beaches and barrier islands act as buffers for coastal marshes and communities, absorbing much of the wave action from the Gulf of Mexico. The problems addressed in this study concerns shoreline and barrier island erosion caused by both man-induced and natural forces. The study identified that increased wave energy and altered water circulation would increase turbidity and salinity, replacing the highly productive estuarine environment with a less productive marine environment.

8. In June 1990, the USACE conducted a reconnaissance study under the Louisiana Coastal Authority entitled Mississippi River Delta Study. The purpose of this study was to determine the feasibility of realigning the lower Mississippi River channel to increase its marsh-building capacity. The general study finding was that there are no economically justified alternatives for making realignments to the Mississippi River.

9. In September 1984, an initial evaluation report Louisiana Coastal Area, Louisiana, Water Supply was prepared by USACE which investigated the advisability of improvements or modification of existing improvements, in the interest of water supply, in the coastal area of Louisiana. The report recommended that five of the six problem areas identified be further investigated in the cost-shared feasibility phase of the study.

10. In March 1989, the reconnaissance report Louisiana Coastal Area, Hurricane Protection investigated hurricane induced storm surges associated with anticipated future losses of coastal wetlands and barrier islands in Louisiana. The USACE prepared a report, certified in March 1989, recommending that the study proceed into the cost shared feasibility phase.

11. In April 1990, a report entitled Land Loss and Marsh Creation, St. Bernard, Plaquemines, and Jefferson Parishes, Louisiana was published by USACE under the LCA Authority. The report presents the findings of feasibility phase investigations for utilizing Mississippi River water and sediment through diversions and direct placement to address the loss of vegetated wetlands in coastal Louisiana.

Other pertinent studies, reports, and projects not prepared under the LCA Study authority are as follows:

There are numerous existing projects within the study area that have been created under various congressional authorizations. These projects include navigation related projects under the Rivers and Harbors Act, Mississippi River & Tributary Project (Flood Control Act 1928) and hurricane protection/ flood controls (Flood Control Act of 1965).

12. In 1942, a report entitled Louisiana-Texas Intracoastal Waterway, New Orleans, Louisiana to Corpus Christi, Texas was published as House Document No. 230, 76th Congress, 1st Session. The report and prior River and Harbor Acts provide for the construction of a 384.1-mile channel 12 ft deep by 125 ft wide from the mouth of the Rigolets to the Sabine River. The project was authorized for construction by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944.

13. In 1945, a report entitled Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana was published as House Document 215, 76th Congress, 1st Session. The report recommended a navigation channel 35 ft to 40 ft deep by 800 ft to 1,000 ft wide. Construction of the channel was completed in 1963. The General Design Memorandum Supplement No. 2, dated April 1984, provides for the restoration of deteriorated bank lines below Venice, Louisiana, and along Southwest Pass with rock foreshore dikes and hydraulic fill to reduce shoaling.

14. In 1951, a report entitled A Report on the Relationship of Agricultural Use of Wetlands to the Conservation of Wetlands in Cameron Parish, Louisiana was published by the USDA-Soil Conservation Service. This report contained information on the relationship of agricultural wetland uses and wetland conservation efforts in Cameron, Parish Louisiana.

15. In 1951, a report entitled Relationship of Wildlife to Agricultural Drainage and Economic Development of Coastal Marshes in Cameron Parish, Louisiana was published by the USFWS. This report contained information on the wildlife and agricultural drainage/economic development relationship for coastal marshes in Cameron Parish.

16. In 1959, L.M. McBride and Edmund McIlhenny authored a report entitled Survey and Report of Vermillion Corporation in Opposition to Project (Fresh Water Bayou Canal Project).

17. In 1958, a report entitled Barataria Bay, Louisiana was published as House Document No. 82, 85th Congress, 1st Session. The project provides for a 12- by 125-ft navigation channel approximately 37.0 miles long beginning at the GIWW and extending to Grand Isle, Louisiana. These improvements were authorized by the River and Harbor Act of 3 July 1958. All work was completed in December 1967.

18. In 1962, a USACE report entitled New Orleans to Venice, Louisiana Hurricane Protection was published as House Document 550, 87th Congress, 2nd Session. The project provides hurricane protection to developed areas in Plaquemines Parish along the

Mississippi River. The locally constructed back levee from City Price to Venice, Louisiana, on the west bank would be brought up to grade. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees. Construction is approximately 80 percent complete with estimated completion in 2017.

19. In 1964, a report on the Mississippi River and Tributaries project, published as House Document No. 308, 88th Congress, 1st Session, recommended construction of the Mississippi Delta Region project. The project provided for four salinity control structures to introduce freshwater into the delta region. These improvements were authorized by the Flood Control Act of 1965.

20. In 1965, the Lake Pontchartrain, LA, and Vicinity Hurricane Protection Project (LP&V-HPP) was authorized by the Flood Control Act of 1965; additional authorization was given through the Water Resources Development Acts of 1974, 1986, 1990, and 1992. The project provides for hurricane protection for the metropolitan New Orleans area by constructing hurricane protection levees and appurtenant features. Construction was initiated in 1967 and is ongoing with over-all project completion scheduled for 2013.

21. In 1965, the Larose to Golden Meadow Hurricane Protection Project was authorized by Flood Control Act of 1965, House Document 184, 89th Congress, Public Law 89-298. The Larose to Golden Meadow Project is located along Bayou Lafourche in south Louisiana. It consists of a 43-mile ring levee that provides hurricane protection and approximately 8 miles of low interior levees that regulate intercepted drainage for lands on both banks of the bayou from Larose south to Golden Meadow. There are two floodgates, one at the upper bayou crossing and another at the lower bayou crossing, that maintain navigation in Bayou Lafourche. The first levee lift was completed in 1975. The final levee lift to the 100-year elevation is scheduled for completion in 2003.

22. In 1973, an eighteen report series, Hydrologic and Geologic Studies of Coastal Louisiana, and the final report entitled Environmental Atlas and Multi-Use Management Plan for South-Central Louisiana were prepared by the Center for Wetland Resources, Louisiana State University under a contract with USACE. The studies examined and identified trends in the coastal area resulting from natural processes and human activities, identified significant environmental parameters, determined the fresh water required to implement changes for fish and wildlife enhancement, and developed management and structural approaches to problem-solving in the estuarine environment.

23. In 1978, Barney Barrett et al. authored a technical bulletin entitled Study of Louisiana's Major Estuaries and Adjacent Offshore Waters LDWF – Seafood Div., Technical Bulletin No. 27.

24. In 1979, a report sponsored by the USFWS entitled An Ecological Characterization Study of the Chenier Plain Coastal Ecosystem of Louisiana and Texas was published. This

report contains information on the biological, physical, and social parameters in the Chenier Plain of Louisiana and Texas.

25. In 1980, the USFWS produced a report entitled Mississippi Deltaic Plain Region Ecological Characterization. The report supplies information about the biological, physical, and social parameters in the Mississippi Deltaic Plain region of Louisiana. Portions of the USFWS report were used in the present study.

26. In June 1980, the Grand Isle and Vicinity, Louisiana, Phase II General Design Memorandum was issued by USACE. The report contains detailed studies of a combined beach erosion and hurricane protection plan for the shore of Grand Isle. Design features include beach fill, vegetated dunes, and a jetty

27. In 1981, a report entitled New Orleans-Baton Rouge Metropolitan Area, Louisiana was completed by USACE. The report contains a comprehensive plan for development and conservation of water and related land resources in a 21-parish area. The report includes 10 parishes in the current study.

28. In 1981, a report entitled Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana was prepared by USACE. The report recommended deepening the Mississippi River to a project depth of 55 ft from the Gulf of Mexico to the Ports of New Orleans and Baton Rouge. Dredged material would be placed in subsiding areas east and west of the river below Venice to create 11,600 acres of marsh over a 50-yr period. The project was authorized by the 1985 Supplemental Appropriations Act of 1986, dated 17 November 1986. Construction of Phase I of the project, a 45-ft channel to mile 181 Above Head of Passes, was completed in December 1988.

29. In June 1982, a report entitled Louisiana’s Eroding Coastline: Recommendations for Protection was published by Coastal Environments, Inc., through a contract with LDNR. The report recognizes that future losses of coastal wetlands are unavoidable and will require either retreat of development from the coastal region of increasingly greater levels of protection. Areas with erosion problems were identified and ranked according to severity. The report recommends a number of pilot projects using water and sediment diversions, dredged material placement, and planted vegetation as ways to reduce erosion. A study to determine future coastal conditions including changes in shoreline configuration and impacts on developed areas is also recommended. Information on erosion and shoreline changes was used in defining problem areas and evaluating alternative plans.

30. In 1982, the USFWS published the Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options, edited by D.F. Boesch. The proceedings provide a current compendium of information on the natural and man-induced causes of land loss, their impacts on natural resources production and man’s use of the area, and possible means of reducing land loss.

31. In April 1994, a report entitled Mississippi River and Tributaries - Morganza, Louisiana to the Gulf of Mexico Reconnaissance Report was published by the USACE. The reconnaissance analysis used available data and preliminary field investigations to establish existing conditions, determine the extent of flooding problems, and develop a wide array of alternative solutions. The USACE, the Terrebonne Levee and Conservation District (TLCD), and the public, through the regulatory process, generated numerous flood protection alternatives for a large study area extending from the East Atchafalaya Basin Protection Levee (EABPL) to the western Mississippi River guide levee. The proposals connected existing and permitted forced drainage levees and utilized existing pump stations and flood control structures where possible. In addition, the proposals included new floodgates and water control structures of varying sizes to form a comprehensive system of flood protection, drainage, navigation, and environmental enhancement in Terrebonne Parish. Four flood protection alternatives were determined to be economically feasible and environmentally acceptable. Congress authorized the multipurpose feasibility study in the Energy and Water Development Act of 1995.

32. In January 1996, the Louisiana Barrier Shoreline Feasibility Study was authorized by the CWPPRA Task Force and conducted to assess and quantify wetland loss problems linked to protection provided by barrier formations along the Louisiana coast. The study identified solutions to these problems, attached an estimated cost to these solutions, and determined the barrier configuration that will best protect Louisiana's significant coastal resources from saltwater intrusion, storm surges, wind/wave activity, and oil spills. These resources include, but are not limited to, oil and gas production and exploration facilities, the Strategic Petroleum Reserve, pipelines, navigable waterways, and fragile estuarine and island habitats.

33. In July 2000, the Mississippi River Sediment, Nutrient and Freshwater Redistribution Feasibility Study was conducted under the CWPPRA authority. The purpose of this study was to: (1) determine means to quantify and optimize the available resources of the Mississippi River to create, protect, and increase coastal wetlands and dependent fish and wildlife populations in coastal Louisiana; and (2) to plan, design, evaluate, and recommend for construction projects utilizing the natural resources of the Mississippi River in order to abate continuing measured loss of this habitat and restore a component of wetland growth.

34. The NRCS has published soil surveys on all of the coastal parishes. These provide detailed soils information in addition to uses and limitations of land use as a result of these soils. Cooperative River Basin Studies have also been published by the NRCS. These contain current and historic descriptions of basins and provide detailed management alternatives of hydrologic units within these basins. The published coastal reports include: Lafourche-Terrebonne, 1986; East Central Barataria, 1989; Calcasieu-Sabine, 1994;Mermentau, 1997; Teche-Vermilion, 1999.

35. In October 2003, a preliminary draft reevaluation report and environmental impact statement entitled Mississippi River & Tributaries, Atchafalaya Basin, Louisiana – Lower Atchafalaya Basin Reevaluation (LABR) Study was submitted by the New Orleans

District of the U.S. Army Corps of Engineers to the Mississippi Valley Division for review and comment. The recommended plan presented in the LABR preliminary draft reevaluation study would involve continued implementation of the authorized features of the Atchafalaya Basin Floodway System, Louisiana Feasibility Study dated January 1982, with the exception of three features that were no longer necessary. These features are 1) enlargement of the Wax Lake Outlet Overbank Structure, 2) channel training works below Morgan City, and 3) no further implementation of a controlled flow distribution between the Wax Lake Outlet and the Lower Atchafalaya River. Additionally, the draft recommendations include the request for further investigations into the feasibility of replacing the Avoca Island Levee Extension feature with the Levees East of Morgan City feature. This further study will include hydrologic and hydraulic analysis, hydraulic modeling, surveys, fisheries studies, and the necessary environmental studies. The Levees East of Morgan City feature, as presented in the LABR preliminary draft report, will included a lock and pump station (12,000 cfs) at Amelia, LA; a pump station (3,000 cfs) at the Elliot Jones Canal and the appropriate levee and floodwall system. During the development of the LABR preliminary draft report, several investigations were conducted to determine if a jetty extending from Point Chevreuil into the Gulf of Mexico was required as a mitigation feature of the MR&T project. Through these investigations it was determined that such a feature is not a mitigation feature of the MR&T projects. However, it was determined that such a feature could have sufficient environmental benefits to justify construction. The preliminary draft recommendations included in the LABR study indicate that this feature should be fully investigated under an environmental authority. The LDNR is currently engaged in a preliminary study to examine the engineering feasibility and environmental impacts of constructing this feature. These efforts will be included in future LCA detailed studies.

36. The <u>Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana Feasibility Study</u> is currently underway. The study is a multi-purpose study, with emphasis on examining the feasibility of deepening the channel to the Morgan City/Amelia Industrial Area and maximizing coastal restoration and delta development opportunities. The study was initiated in May 2002 and is scheduled for completion in May 2005. This study will examine in detail, different alternatives (including channel diversions) for maximizing the use of river sediments (both dredged and un-dredged) to restore eroding coastal areas in conjunction with providing improvements to the navigation channels. The ecosystem restoration components contained in this study may be included in future LCA detailed studies and implemented as a part of the LCA Plan.

<u>Other Federal projects within the study area include:</u>

37. <u>Old River complex</u>. The Old River complex consists of three structures: the low sill structure, the auxiliary structure, and the overbank structure. The low sill and overbank structures were completed in 1963. The low sill structure was damaged during the 1973 flood. Rehabilitation of the structure was undertaken, but the integrity of the structure to function as designed during future high water events was questionable. Consequently, construction of an auxiliary structure to supplement the low sill structure was completed in 1986. The privately owned Sidney A. Murray, Jr. Hydroelectric Power Station

(completed in 1989) is located just upstream of the over bank structure, and pursuant to a certain Memorandum of Agreement, dated December 13, 1989 between the United States of America and the Town of Vidalia and the Catalyst Old River Hydroelectric Limited Partnership, significant portions of the Old River flows are presently being diverted to the Atchafalaya River through the plant for power generation instead of passing through the federal structures. Among other things, daily operation of the Old River complex consists of regulating the low sill structure, the auxiliary structure, and the power station so that of the total flow from the Red and Mississippi Rivers at the latitude of Old River, 30 percent passes down the Atchafalaya River and 70 percent down the Mississippi River on a yearly basis. The overbank structure has been used during high water events. The maximum design capacity for the complex during a project flood is 620,000 cfs. The Old River lock, which allows navigation between the Mississippi and Atchafalaya Rivers, is located approximately 10 miles downstream of the Old River complex.

38. <u>The East Atchafalaya Basin Protection Levee (EABPL).</u> The EABPL begins at the lower end of the Morganza Floodway lower guide levee and extends southward through Morgan City to Avoca Island Cutoff and includes Bayou Sorrel and Bayou Boeuf Locks. The length of this levee is 87.2 miles, including about 17.2 miles of floodwall in the vicinity of Morgan City.

39. <u>West Atchafalaya Floodway</u>. The West Atchafalaya Floodway (the west side artificial intake for the Lower Atchafalaya Basin Floodway) comprises an area of about 170,000 acres. This intake is bounded on the north by the Bayou Des Glaises fuse-plug levee, on the west by the WABPL, and on the east by the West Bank Atchafalaya River Levee. The lower limit of the West Atchafalaya Floodway is approximately at the latitude of Krotz Springs. The design capacity of the West Atchafalaya Floodway is 250,000 cfs above Bayou Current and 400,000 cfs below Bayou Current. This floodway is used only for the passage of flood flows. To date, the floodway has never been operated.

40. <u>Wax Lake Outlet (WLO).</u> The WLO was constructed to improve the capability of the features of the Atchafalaya Basin Project to pass flood flows to the Gulf of Mexico. This dredged channel, located about 10 miles west of Berwick, extends from Six Mile Lake through the Teche Ridge and Wax Lake into the Atchafalaya Bay, a distance of about 16 miles. The present design capacity of the WLO is 440,000 cfs.

41. <u>Lower Atchafalaya River (LAR).</u> The LAR, the natural outlet for the Lower Atchafalaya Basin Floodway, begins just north of Morgan City and flows southward through the Atchafalaya Bay to the Gulf of Mexico. The present design capacity of the Lower Atchafalaya River is 1,060,000 cfs.

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Attachment 3

Non-Federal Sponsor Financial Capability

A breakdown of the Federal and non-Federal cost sharing for the project is displayed in table MR 6-4, of the Main Report. The State of Louisiana has been an active participant throughout the development of the LCA Plan and has reviewed a preliminary draft of the cost-sharing agreement. It has also provided the District with a letter of intent indicating that the State understands the responsibilities incumbent on the non-Federal sponsor. The State intends to enter into a binding agreement with the USACE for each element at the appropriate time. This agreement, called the Project Cost Sharing Agreement (PCA), would include a statement of financial capability and a financing plan, each of which would be prepared by the State and signed by an appropriately authorized state official. The financing plan would specifically identify the source of project funding and the annual revenues generated from this source in order to ensure that sufficient funds are available on a cash-flow basis to meet non-Federal cost-sharing responsibilities for each fiscal year. Also included in the PCA would be a Commander's Assessment of the non-Federal Sponsor's Ability to Cost Share, which would be prepared and signed by the USACE-MVN District Engineer.

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Attachment 4

Non-Federal Sponsor Notice of Intent

State of Louisiana
OFFICE OF THE GOVERNOR
Baton Rouge
70804-9004

KATHLEEN BABINEAUX BLANCO
GOVERNOR

POST OFFICE BOX 94004
(225) 342-7015

June 3, 2004

Col. Peter Rowan
New Orleans District
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Col. Rowan:

The rate of land loss within the Louisiana coastal ecosystem is staggering and the scale of effort needed to address it has never before been attempted. Rehabilitation of this natural system is critical to the economic and energy security of both the state and the nation, the safety of more than two million residents, the ecological balance of the Gulf region, and the survival of a unique culture. As a 50/50 cost share partner with the Corps on the *Louisiana Coastal Area, Louisiana-Ecosystem Restoration Study* in support of the first phase of implementation, the state of Louisiana is submitting this letter of intent as evidence of its firm commitment to continued collaboration and support through the recommended *America's Wetland – Coastal Louisiana Ecosystem Protection and Restoration* section of the proposed 2004 Water Resources Development Act (WRDA).

As we enter the first phase of implementation, we understand that construction of plan elements requires a 35% non-Federal cost share under current law and Administration policy and are aware of the non-Federal responsibilities as they are described in the report. It is the state's intent to cost share implementation of the recommendations and, while this letter is not legally binding to the state in any way, to demonstrate our support for starting plan implementation. However, the state intends to urge the Congress to reduce Louisiana's cost share to 25% because of impacts to the nation's economy, energy security and environment caused by the wetland loss and the unintended consequences of Federal actions taken that have, in part, contributed to the land loss.

Several outstanding issues remain that will need to be addressed prior to program implementation. These issues will be detailed in the "Views of the Local Sponsor" section of the final report.

Col. Rowan
Page 2
June 3, 2004

I would like to express my personal support for continuing this important work. A long-term, comprehensive approach to the sustainable restoration and rehabilitation of our coastal ecosystem is of vital importance to the state of Louisiana and to the nation as a whole. As we embark on this first phase of implementation, I look forward to working with you as we move toward achieving that goal.

Sincerely,

Kathleen Babineaux Blanco

Kathleen Babineaux Blanco
Governor
State of Louisiana

Attachment 5

Additional Information on Five Near-Term Critical Restoration Features for Conditional Authorization

Mississippi River - Gulf Outlet Environmental Restoration Features

Small Diversion at Hope Canal

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island

Small Bayou Lafourche Reintroduction

Medium Diversion with Dedicated Dredging at Myrtle Grove

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Mississippi River - Gulf Outlet Environmental Restoration Features

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Mississippi River - Gulf Outlet Environmental Restoration Features
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

This near-term restoration feature involves the construction of shoreline protection measures such as rock breakwaters along the north bank of the MRGO and along important segments of the southern shoreline of Lake Borgne, as well as the investigation of various environmental restoration strategies requested in response to public concerns over the proposed plan to stabilize the MRGO navigation channel. The natural ridges along these selected shoreline segments are in danger of breaching in the very near future because of ship wakes along the channel and erosion from wind-driven waves along the lakeshore. Once these ridges are breached, the wetlands protected by these ridges become vulnerable to natural and man-made erosive forces that will quickly work to degrade the wetlands. Strategic placement of similar protective breakwaters has been effectively used along the MRGO in other locations to prevent bankline retreat and to protect large areas of estuarine wetlands from further erosion and degradation. The breakwaters may also facilitate future wetland creation using dedicated dredging and/or beneficial use of dredged material by serving as containment and protection for the restored wetlands. Additional ecosystem restoration features including marsh creation, freshwater introduction, barrier island restoration, and channel modification will be investigated to develop a suite of measures to stabilize and maintain important estuarine components.

Although current operation and maintenance (O&M) practices along the navigation channel include bankline stabilization, that task is executed primarily to reduce future maintenance dredging activities by reducing the amount of material sloughing from the bankline and shoaling in the navigation channel. However, the channel O&M program's purpose and funding is not designed to address the critical environmental protection and restoration needs of the area. The New Orleans District Operations Division has evaluated test sections and developed several plans for bank protection along the MRGO utilizing rock breakwaters and articulated concrete mats. Cost estimates for this proposed restoration feature are based on previously constructed rock breakwaters; however, articulated concrete mats or other bankline stabilization methods could be used depending on localized conditions and opportunities.

The MRGO is currently undergoing a reevaluation of the economic viability of the existing MRGO navigation channel for deep-draft navigation. The outcome of this study will provide the direction for MRGO ecosystem restoration options based upon whether or not the channel should be maintained for ship traffic. Additional investigations will be conducted under the LCA Plan to develop a plan that not only addresses navigation needs, but also addresses various environmental restoration strategies, including evaluation of freshwater reintroductions into the Central Wetlands, possible channel depth modifications, and construction of a navigation/water control structure to restore the Bayou la Loutre Ridge. As long as the MRGO remains authorized to provide deep-draft navigation, ecosystem protection measures are critically needed to minimize further wetland loss and to preserve the opportunities for future restoration. This includes preventing erosion of the MRGO channel banks from ocean-going vessel wakes. Wave wash and drawdown caused by deep-draft vessel traffic are responsible for much of the bank erosion along the channel. Shallow draft barge traffic, commercial fishing vessels, and recreational watercraft also contribute to bank erosion along the waterway. Continued operation of the channel will result in further bank erosion and loss of adjacent coastal wetlands. Also, if not quickly addressed, the continuing erosion of the southern Lake Borgne shoreline from wind-driven waves could cause breaching of the shoreline in several locations, threatening the integrity of marshes between the lake and the MRGO. Without action, critical landscape components that make up the estuarine system would be lost and future restoration efforts would be much more difficult and costly. In certain cases, failure to act to protect these areas would likely result in the permanent loss of ecosystem structural components that cannot be replaced using existing restoration techniques.

Critical action points to avoid near-term (3 to 5 years) threats of shoreline and bayou breaches are located at Bayou Bienvenue, Bayou Mercier, Proctor Point, Alligator Point, Bayou Biloxi, Bayou Magill, and Antonio's Lagoon. These sites face significant risk of losing the integrity of bayou banks along the lake shoreline and potential major breaches of the navigation channel into the lake. Loss of bayou bankline stability would result in higher rates of erosion and destruction of limited and diverse habitats that offer fish and wildlife refuge from open lake conditions. A breach between the lake and the MRGO navigation channel would result in rapid wetland loss as storm waves from the lake and ship wakes from the channel impact sensitive interior wetlands and submerged grass beds in protected ponds. Further impacts from breaches would occur as scarce sediment is exported into deeper water and out of the wetland system.

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.
- Construct 15 miles of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

A second phase of the MRGO Environmental Restoration Features (conducted under the "Modifications to Existing Structures" element of the LCA Plan) would take into consideration the navigation authority, but could recommend future ecosystem restoration activities that include closure or modification of the MRGO channel or channel relocations necessary to meet restoration goals. This phase would investigate and develop additional ecosystem restoration features including dedicated dredging and beneficial use of dredged material for marsh creation, freshwater introduction, barrier island restoration, and channel modification to develop a suite of measures to stabilize and maintain important estuarine components.

Description of Area/Background

The study area is located in Orleans, St. Bernard, and Plaquemines Parishes in southeastern Louisiana. The area is generally bounded by Lake Pontchartrain on the north, the Mississippi River on the south and west, and Lake Borgne, Breton Sound, and the Gulf of Mexico on the east and south (see **figure 1**). The study area includes the wetlands surrounding

Lake Pontchartrain and parts of the City of New Orleans, St. Bernard Parish, and Plaquemines Parish. The area potentially affected by change in navigation depth includes the navigation channels and related land areas in the study area and in the inland waterway system on the Gulf Intracoastal Waterway (GIWW) and the Mississippi River.

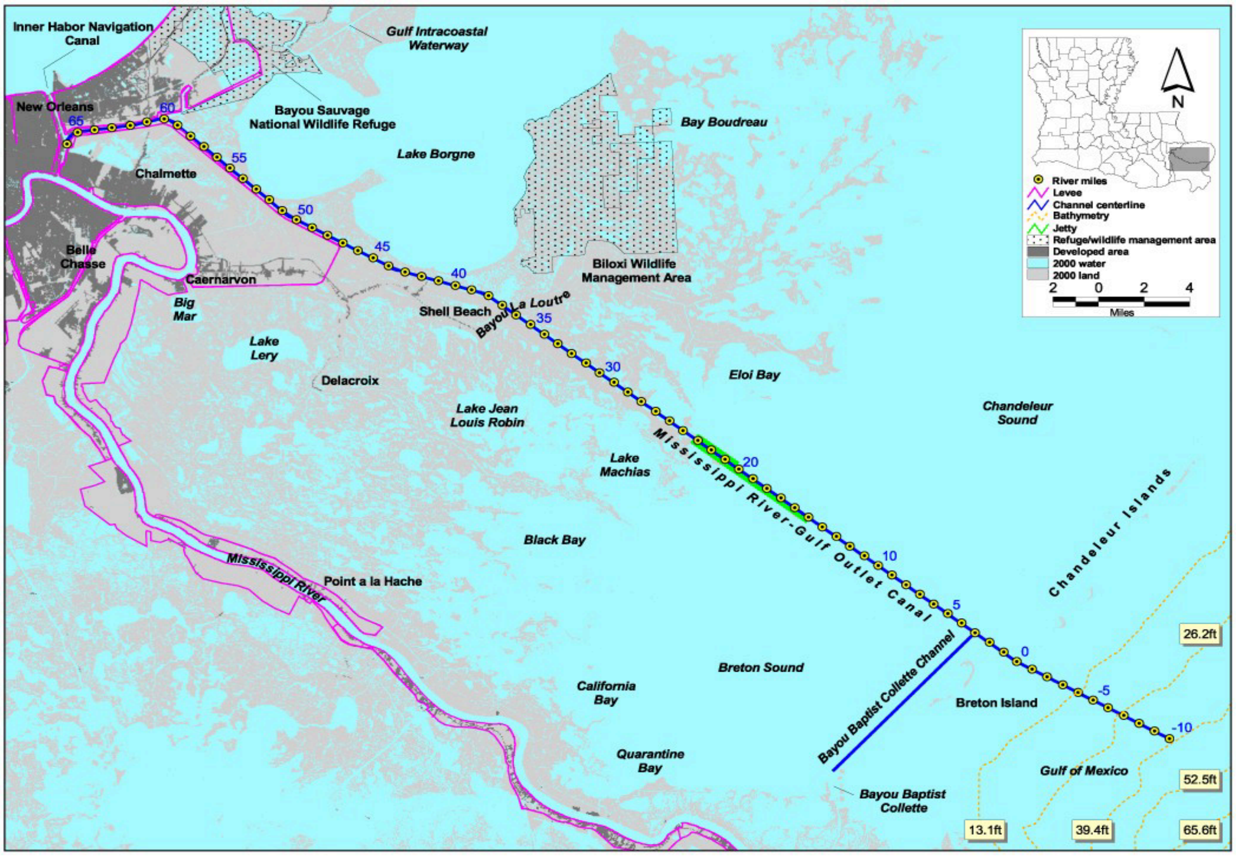

Figure 1. Mississippi River-Gulf Outlet Project Area

The Rivers and Harbors Act of 1956 and the Water Resources Development Acts of 1976, 1986, and 1996 authorized the MRGO as a 36-foot deep by 500-foot wide and 76-mile long channel. The MRGO extends from the Inner Harbor Navigation Canal (IHNC) in New Orleans to the 38-foot depth contour in the Gulf of Mexico (see **figure 1**). Dredging for channel construction began in 1958 and the channel was opened for deep-draft maritime traffic in 1968.

Dredged through shallow bays, coastal marshes, ridges, and cypress swamps, the channel was constructed to provide an outlet from the Mississippi River in the interest of National defense, general commerce, and to provide a safer and shorter route between the Port of New Orleans and the Gulf of Mexico. Business interests in Orleans and St. Bernard parishes, the State of Louisiana, the Board of Commissioners of the Port of New Orleans, and the navigation industry all supported construction of the channel. Construction of the MRGO caused widespread wetlands loss and damages to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin.

The MRGO also connects to the Michoud Canal, which is a private deep-draft navigation canal in operation, unrelated to the public actions of the Port of New Orleans. A new lock at the IHNC is a Congressionally authorized project currently under construction and scheduled for completion in 2017. The lock will replace an existing structure that was built in the late 1920s.

Congressional appropriations for the MRGO navigation project are approximately $12.5 million annually for O&M activities. However, analysis of actual channel maintenance costs indicates that the average annual maintenance expenditures between 1995-2004 were $18.4 million per year. The majority of this funding is spent on maintenance-dredging actions that occur at varying time intervals, depending upon need, along the length of the MRGO. Increases in maintenance costs occur following tropical storm and hurricane events that impact the shoaling rates in the channel.

Maintenance-dredging activities provide opportunities for using material beneficially for the creation of coastal habitat. It is estimated that 285 acres of coastal habitat could be created each year with the full beneficial use of maintenance-dredged material under the current channel authorization. As long as the channel is authorized it is anticipated that similar opportunities will remain available as part of the channel O&M plans. However, current O&M funding limitations and uncertainties prohibit the district from maximizing the beneficial use of maintenance-dredged material.

Maintenance dredging occurs annually in the bar channel (Mile -4 to Mile -9.38) with materials disposal in the approved Ocean Dredged Material Disposal Site (ODMDS) in the Gulf of Mexico. About every two to three years, maintenance dredge-occurs in the reach from Mile 3.4 to Mile -2, with beneficial use of the dredged materials under the O&M Program to restore habitat on Breton Island. When available, Section 204 funding is applied to place dredged materials from Mile -2 to Mile 4 on Breton Island. Otherwise, the materials are placed in the ODMDS. The reach from Mile 23 to Mile 3.4 is dredged about every other year, with the dredged materials beneficially placed in single point discharge (SPD) locations within the designated open water disposal site in Breton Sound for aquatic habitat enhancement. Materials from Mile 23 to Mile 14 are placed in SPDs for wetland creation behind the north and south jetties.

When Continuing Authorities Program Section 204 funds are available, the maintenance-dredged materials from Mile 14 to Mile 12 are also placed behind the north and south jetties near Breton Sound and Gardner's Island for wetland creation. The reach from Mile 27 to Mile 23 is dredged about every three years, with materials placement behind the north and south jetties in SPD locations for wetland creation. Dredging of the inland reaches (Mile 66 to Mile 27) of the channel occurs about every five to eight years, and is conducted by using environmental best management practices (BMPs) for the creation of wetlands. The majority of the inland reach dredged material is placed in marsh creation sites located between the north bank of the channel and the south shore of Lake Borgne.

Over the next 50 years, it is anticipated that the following actions associated with dredging for operations and maintenance of the MRGO will occur:

- Inland reach (mile 66 to mile 27) dredging of 0.723 million cubic yards per year with beneficial use marsh creation of an estimated 85 acres of wetlands per year.
- Jetty reach (mile 27 to mile 12) dredging of 1.308 million cubic yards per year with beneficial use marsh creation of an estimated 115 acres of wetlands per year.
- Open water reach (mile 12 to mile -4) dredging of 1.136 million cubic yards per year with beneficial use marsh creation of an estimated 85 acres of wetlands per year.
- Bar channel (mile –4 to mile –9) dredging of 0.579 million cubic yards per year placed in the ODMDS.

The USACE has developed several plans for bank protection along the MRGO as part of the channel O&M plan. These plans have been linked to reductions in the annual volume of maintenance-dredged material that must be removed. The program has demonstrated that installing bank protection reduces the amount of shoaling in the protected reaches and thus reduces the amount of maintenance dredging that is required. The investment return on bank protection performed along the inland reach is aimed at attaining cost savings on maintenance dredging into the future, as well as to provide greater environmental sustainability along the waterway by protecting adjacently residing coastal habitats. There are plans at present under the O&M Program for future bank protection using traditional foreshore rock protection along the north bank, as well as continued maintenance of the existing bankline protection along the inland reach. The O&M bank protection program includes scheduled foreshore and dredged materials retention rock between Mile 24 to Mile 28 on the south bank, and Mile 43 to Mile 45.5 on the north bank. Additional plans over the next 50 years include installing bank protection at channel Mile 29 to Mile 30 on the south bank, and Mile 29 to Mile 32 and Mile 57 to Mile 59 on the north bank (see **figure 1**).

Alternative bank protection measures have been investigated along the south bank of the channel. A series of articulated concrete mattress (ACM) test sections were placed directly on the bankline. The installed test sections have performed very well in preventing bankline erosion along the channel and are forecast to require very little to no subsequent maintenance. Plans over the next 50 years include installing ACM along the southern bank of the channel between approximate Mile 27 and Mile 46 as part of the channel O&M actions.

Problems and Needs

Construction and maintenance of the MRGO caused widespread wetland loss and damage to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin. During construction of the MRGO, dredging and filling destroyed more than 19,000 acres of wetlands, and an important hydrologic boundary was breached when the channel cut through the ridge at Bayou la Loutre.

After the MRGO was completed, significant habitat shifts occurred because the impacted area converted to a higher salinity system with the influx of saltwater through ridges and marsh systems that were severed or destroyed during channel construction. Continued operation of the MRGO results in high rates of shoreline erosion from ship wakes, which destroy wetlands and threaten the integrity of the Lake Borgne shoreline and adjacent communities, infrastructure, and cultural resources. In addition, severe erosion of the MRGO channel continues to facilitate the transition of the upper Pontchartrain Basin estuary toward a more saline system.

Annual erosion rates in excess of 35 feet along the north bank of the MRGO result in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange through the modified watercourse system. These vegetated habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon.

Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds. The highest rates of erosion in the area occur along the north bank of the MRGO channel. The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake/marsh rim, which would result in the coalescence of the two water bodies. A breach would accelerate marsh loss.

Prior to construction of the MRGO, tidal flow into Lake Borgne was dominated by flow from Mississippi Sound because the tidal flow from the Breton Sound area was reduced as it moved northwest across the marshes and wetlands through bayous and ponds toward Lake Borgne. Construction of the MRGO caused a reversal of the former circulation pattern, with the dominant tidal flow into Lake Borgne now coming from the Breton Sound area directly via the MRGO. Before construction, habitats in the area were aligned along salinity gradients and reflected the varied landscape and interspersed watercourses.

A number of factors have contributed to the alteration of circulation patterns and water quality since the completion of construction of the MRGO. The MRGO is a deep channel that provides a more direct flow of more saline, higher density water inland into Plaquemines, St. Bernard, and eastern Orleans parishes. The channel provides a direct passage for tidal exchange and allows any freshwater surpluses to exit at low tide and be replaced by the inflow of more saline water at high tide.

Dredged material from the construction dredging of the MRGO channel was deposited in a 4,000-foot wide continuous strip along the channel's southwestern side, interrupting the circulation patterns of the natural waterways that transected the length of the channel and connecting a solid upland to form the southern portion of the Lake Borgne watershed. This dredged material disposal area covers approximately 25 square miles of former vegetated wetlands and shallow estuarine waters. Creation of the dredged material area resulted in the disruption of water flow and semi-impounded wetlands on the southwestern side of the spoil bank causing water quality problems and affecting the quality and integrity of the marsh habitat.

The alteration of salinity levels in waters along the MRGO channel and outward into adjacent areas was first observed in studies conducted immediately following construction of the channel. The influx of more saline water into these areas resulted in a continual increase in salinity until a new equilibrium was reached. The MRGO is a straight and deep channel in comparison with the natural meandering shallow lagoons and characteristically sluggish water movement found in the area. Greater volumes, more rapid mixing, and deeper penetration of saltwater are responsible for higher salinities in surface waters and marsh areas adjacent to the MRGO and in Lake Pontchartrain.

An investigation of various combinations of depth and width reductions in relation to salinity changes titled “Salinity Changes in Pontchartrain Basin Estuary, Louisiana, Resulting from Mississippi River-Gulf Outlet Partial Closure Plans with Width Reduction” was published by the USACE, Engineering Research and Development Center (ERDC) in August 2002. The study includes a base condition of the authorized channel and the results clearly show the impacts of elevated salinity throughout the MRGO influence area.

The ERDC report data indicates that area salinity is lowest in the late spring and highest in the summer and fall. This is reflective of the seasonal variations in the fresh-water inflows from the major rivers and streams into the basin. The salinity in Lake Pontchartrain generally ranges from 2 to 15 parts per thousand (ppt) and is influenced greatly by Pearl River discharges and inflows from the Rigolets and Chef Pass. Higher salinity water from the MRGO enters the western regions of Lake Borgne through breaks in the marshes between the two water bodies and then enters Lake Pontchartrain through the opening of the Industrial Canal at the Seabrook Bridge and the Chef Pass and the Rigolets.

The analyses of the salinity data indicate that there was an increase in monthly average salinity for all months after 1963. This increase falls directly after the partial completion of the MRGO in 1963, which provided a major access for salt water to enter Lake Maurepas, Lake Pontchartrain, and Lake Borgne. No other major events occurred at that time to cause such an increase in the salinity.

Monthly summaries of salinity for pre- and post-MRGO indicate that salinity has increased on the average by the following amounts:

- 0.4 ppt at Pass Manchac near Pontchatoula.
- 1.1 ppt at Lake Pontchartrain, North Shore (St. Tammany Parish).
- 1.9 ppt at Lake Pontchartrain, Little Woods (New Orleans lakefront).
- 2.3 ppt at Chef Menteur Pass near Lake Borgne (Orleans and St. Bernard Parish).
- 4.5 ppt at Bayou LaLoutre, Alluvial City.

The salinity in the region has stabilized, and no significant increase in average annual salinity is projected in the foreseeable future for Lake Maurepas or Lake Pontchartrain. Salinity is expected to increase in the western Lake Borgne region and surrounding marshes due to land loss in the area (see **table 1**).

Table 1. Mean monthly salinity pre- and post-MRGO 1951 to 1963 & 1963 to 1977

Month	Pass Manchac ppt		North Shore ppt		Little Woods ppt		Chef Menteur Pass ppt		Alluvial City ppt	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
January	1.1	1.5	3.0	4.0	3.9	5.0	3.8	5.7	6.8	9.8
February	1.0	1.5	2.5	3.0	3.0	6.5	2.9	4.8	6.4	9.7
March	1.0	1.2	1.9	2.6	2.3	4.4	2.2	4.3	6.3	10.4
April	0.8	1.3	1.9	2.6	2.4	4.0	2.2	4.0	7.0	10.0
May	1.0	1.1	2.4	2.7	2.2	3.9	2.6	4.0	9.5	10.2
June	1.0	1.5	3.6	3.0	2.2	3.8	3.3	4.2	9.0	12.3
July	1.0	1.6	3.0	4.6	2.1	4.4	3.2	6.3	7.9	16.0
August	1.2	1.7	4.6	5.6	2.5	4.8	4.8	7.5	8.6	16.1
September	1.7	2.0	5.4	7.5	4.5	6.2	6.0	8.5	8.2	12.9
October	1.8	2.2	4.7	7.3	4.9	6.8	5.2	8.4	7.6	13.8
November	1.8	2.1	4.6	6.7	4.8	6.8	5.2	8.0	8.0	13.1
December	1.2	1.8	4.5	5.4	4.7	6.2	4.2	7.0	8.0	12.5
Average	1.2	1.6	3.5	4.6	3.3	5.2	3.8	6.1	7.8	12.2
Salinity Increase		0.4		1.1		1.9		2.3		4.5

Salinity data collected in Lake Eloi, Stump Lagoon, Lena's Lagoon and Lake Borgne from 1960 through 1968 show net increases in salinity following construction of the MRGO. The degree of the increases appears to depend on the initial salinity of a given area prior to construction as well as on the area's distance from the MRGO channel. Lake Eloi, located along the southeastern region of the channel, has shown minimal changes in salinity over time due to its proximate location to the saline waters of Breton Sound and the maintenance of its original circulation patterns. In contrast, the observed salinity increases at Stump Lagoon and Lena's Lagoon are the result of the influx of more saline waters into these areas.

Recent salinity data collected from the Louisiana Department of Environmental Quality (LDEQ) monitoring stations at Lake Eloi located near Mile 25 appear consistent with the data collected following construction of the MRGO. Recent LDEQ data collected from Lake Borgne continues to display fluctuations in salinity that appear more strongly influenced by rainfall and tidal flow unrelated to the construction of the channel. It is likely that the increased salinities observed in Stump Lagoon and Lena's Lagoon following construction of the MRGO will continue because of the influx of high salinity water from the MRGO into these areas. Construction of the MRGO has resulted in steep increases in salinity along its route due to the influx of more saline waters inland along the deepened channel passageway. Recent salinity data from LDEQ monitoring stations, where available, indicate that the influence of the channel in these areas remains today. The inland reduction of salinity in areas along the channel appears to be primarily determined by distance from the more saline source waters.

Habitat change between 1956 and 2000 in the MRGO region has been substantial. In that time, 27,784 acres of marsh habitat have been converted to open water (see **table 2**). Some of this loss is attributable to direct impacts of construction of the MRGO and the continued erosion of the channel banks. However, measured salinity increases associated with the MRGO have contributed to this habitat conversion and land loss.

Table 2. MRGO Habitat Change 1956-2000

Total acreage for the study area in 1956 was 359,123 acres
Total water acreage for the study area in 1956 was 159,518 acres
Total land acreage for the study area in 1956 was 199,605 acres
Total acreage for the study area in 2000 was 359,123 acres
Total water acreage for the study area in 2000 was 187,302 acres
Total land acreage for the study area in 2000 was 171,821 acres
27,785 acres of marsh habitat were converted to open water between 1956 and 2000
16,726 acres of fresh marsh were converted to open water or a different habitat between 1956 and 2000
5,927 acres of nonfresh marsh habitat were converted to open water or a different habitat between 1956 and 2000
36,454 acres of brackish marsh habitat were converted to open water or a different habitat between 1978 and 2000
10,141 acres of open water or marsh habitat was converted to intermediate marsh between 1978 and 2000
19,592 acres of open water or marsh habitat was converted to saline marsh between 1978 and 2000

Construction and operation of the MRGO navigation project resulted in significant changes and damages to habitats in the Lake Pontchartrain, Lake Borgne, and Breton Sound estuaries. Environmental changes and damages associated with the project can be classified into three categories covering construction damages, immediate post-construction hydrologic changes, and long-term operational impacts.

Dredging to construct the channel destroyed wetlands via both the digging and disposal of these sediments. Cutting the channel through marshes, swamps, ponds, bayous, and ridges resulted in modification of natural tidal movement and allowed a direct conduit for high salinity water to move into the inner parts of the estuary.

The influx of saltwater through the MRGO channel caused basin-wide losses of fresh and intermediate marshes as well as cypress-tupelo swamps. The saltwater influx produced an estuary-wide shift in habitat types and associated biological communities to those associated with higher salinity regimes.

Shoreline erosion is occurring along both the north and south banks of the MRGO. Wave wash and drawdown caused by deep-draft vessel traffic is responsible for much of the shoreline erosion along the channel. Shallow draft barge traffic, commercial fishing vessels, as well as recreational watercrafts contribute to bank erosion along the waterway. The erosion rate is approximately 35 feet per year along the north bank and approximately 15 feet per year along the south bank. Continued operation of the channel will result in further erosion and loss of coastal wetlands over a wide area.

Critical Need

Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and marshes and to prevent continued erosion of the MRGO channel banks. Without action, critical landscape components that form the backbone of the Lake Borgne, Lake Pontchartrain, and Breton Sound estuaries would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive. These important landscape components include marshes, ridges, bayous, ponds, submerged grassbeds, and lake shorelines. The rapid rate of shoreline retreat indicates that extensive breaching between the channel and lake will occur over the next ten years. As previously stated, loss of bayou and lake ridges will accelerate this loss and threaten interior marshes that are vulnerable to high rates of erosion when exposed to high-energy wave environments. Protection of the shoreline and channel banks is critical to insuring restoration success in the future.

This feature, including shoreline protection and ecosystem restoration measures, has been identified as a critical need in the ongoing MRGO reevaluation study and should be implemented regardless of any potential changes to the channel authorization. In addition, stabilization of the north bank of the MRGO and maintaining the shorelines of Lake Borgne are identified in the Coast 2050 Report as a near-term (1 to 5 years) regional strategy. Closing the MRGO to deep-draft navigation and various other environmental restoration strategies for the area were also identified in the Coast 2050 report.

Land loss data during five time intervals between the 1930s and 2001 is shown in **figure 2** with each color representing wetlands lost during a specific time interval. Areas identified as loss were mapped by comparing a 1930s' base map to aerial photography flown in 1956-58, 1974, 1983, 1990, and 2001. The original mapping was done at a scale of 1:62,500 (15-min.) during a three-year period and is described in more detail by Britsch and Kemp (1990) and Dunbar, Britsch, and Kemp (1992). This map represents a composite 1930s' base map showing the land loss from individual 15-min. maps reduced for printing purposes. The map is intended to present a regional overview of the distribution and magnitude of land loss and the time periods in which it occurred. The scale at which the data is presented precludes any detailed measurements from the map.

This recent data analysis reveals an alarming trend in land loss rates in the estuarine wetland areas in and around the MRGO corridor. The data indicates that land loss rates have accelerated since 1990 and that the rate of wetlands loss now exceeds the rates experienced in the area during the period of MRGO channel construction. Researchers have noted that the increasing loss rate trend is pervasive throughout the system and not necessarily directly related to the use of the channel. Indications are that widespread wetlands losses are occurring throughout the area and that these losses may represent impacts associated with system-wide causes similar to events occurring in other subprovinces.

Additional factors, not directly associated with the construction, operation, and maintenance of the MRGO channel, contribute to wetland losses. These include subsidence, tropical storms and hurricanes, cold fronts, hydrologic modification, flood control of the Mississippi River, human development, and oil and gas exploration and production. Combined, the systemic wetland loss factors and the channel operation and maintenance are resulting in a widespread decline in habitat quantity and quality in the Lake Borgne and Pontchartrain basins and surrounding aquatic ecosystems. Due to these factors a near-term critical plan must include measures that address factors other than the direct loss of shoreline wetlands from the passage of deep-draft vessels on the MRGO channel.

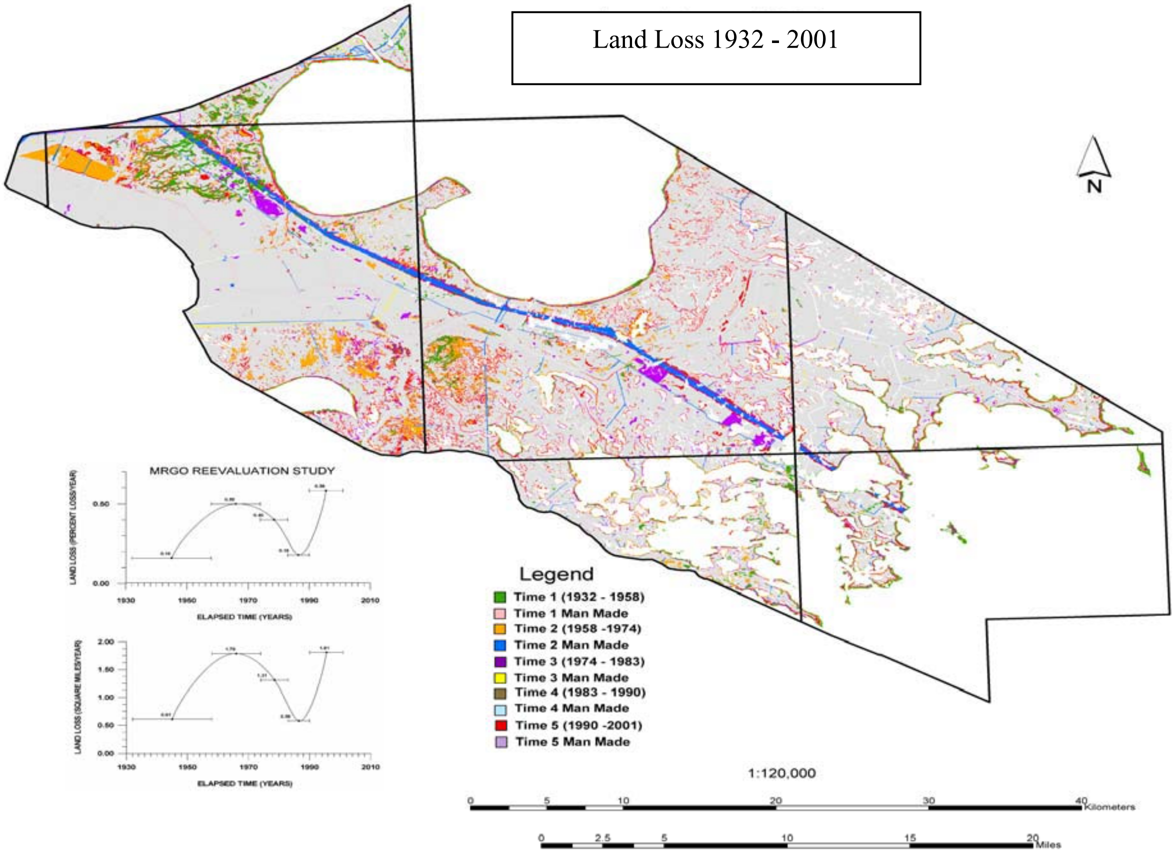

Figure 2. MRGO Study Area Land Loss 1930s - 2001

Table 3. MRGO Project Area Land Loss Rates by Time Period

	Total	Total %	%		
Time Interval	**Acres Lost**	**Land Loss**	**Loss/yr**	**acres/yr**	**sq.miles/yr**
1932-1958	10099	4.2	0.16	388	0.6
1958-1974	18302	8	0.5	1144	1.8
1974-1983	7552	3.6	0.4	397	1.3
1983-1990	2616	1.3	0.18	374	0.6
1990-2001	12727	6.4	0.58	1157	1.8

Without Project Conditions

Shoreline erosion is occurring along both the north and south banks of the MRGO. Wave wash and drawdown caused by deep-draft vessel traffic is responsible for much of the shoreline erosion along the channel. Shallow-draft barge traffic, commercial fishing vessels, as well as recreational boats contribute to bank erosion along the waterway.

Continued operation of the channel will result in further shoreline erosion and loss of adjacent coastal wetlands. The rate of shoreline retreat is approximately 35 feet per year along the north bank and approximately 15 feet per year along the south bank. Modification of the natural hydrology of the area during channel construction has resulted in large-scale shift in the salinity regime of the project area estuaries. Long-term trends indicate that salinity levels will remain high and could continue to increase over time with the deterioration of surrounding habitats creating more direct links to offshore areas containing higher salinity waters.

Table 4. MRGO Bankline Erosion Rate (average feet per year).

Reach by Channel Mile	North Bank (left-descending)	South Bank (right-descending)
65.1 to 59.8	8.7	12.8*
59.7 to 53.0	27.4	
52.9 to 37.8	28.7	
37.7 to 29.1	38.0	
29.0 to 26.8	35.6	
26.7 to 23.1	27.8	
* The erosion rate along the south bank is nearly consistent for the entire inland reach of the navigation channel.		

The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake marsh rim. A breach of the wetlands between Lake Borgne and the MRGO is projected to rapidly accelerate marsh loss rates in the area. These breaches would lead to the coalescence of the two water bodies exacerbating land loss problems and contributing to the continuing decline of this estuarine system.

Annual erosion rates along the MRGO results in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange. These vegetated wetland habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon. Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds that reside in the system or use the area during life cycle migrations.

Alternatives Investigations

In general, few cost-effective alternative methods are available for shoreline protection efforts in the generally poor soil conditions found in the MRGO project area. Demonstration projects to investigate the field performance of alternative methods for shoreline protection have proven the alternatives to be less effective than traditional rock breakwater designs.

Several techniques and designs have been employed in the MRGO area to protect eroding shorelines. These designs include foreshore protection dikes, rock breakwaters, ACM, and geotubes. Experience indicates that the rock breakwater designs are the most certain in terms of performance, benefits, and costs.

Engineering and Design Considerations.

Information has been collected in the area as part of planning and design efforts for operations and maintenance actions and several projects authorized under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program. These design efforts included the collection of water level, wind, and geotechnical information that is important for consideration of engineering performance requirements to meet project goals. This information is project site specific and should not be assumed to be applicable to all projects in the MRGO area. However, as indicated in the data, soil conditions investigated under the CWPPRA efforts were found to be some of the poorest in coastal Louisiana and thus design consideration of this fact would characterize those designs as conservative because of the site conditions.

Lake Borgne has an irregular shape 18 miles long and 16 miles wide as shown in **figure 1**. The south shore of the lake has been eroding due to a combination of land subsidence and wave action from northerly winds. Strong northerly winds frequently occur in the area during the passage of winter cold fronts. Strong winds associated with tropical storms and hurricanes are infrequent events in the area but can cause extensive erosion and habitat damages.

Hydraulic engineers use geographic and environmental information to establish the parameters necessary to achieve the project design goals of stopping shoreline erosion. These efforts involve analyzing historic water level and wind information to develop design elevations, slopes and materials requirements for constructing rock dikes for protecting the project area shorelines.

A water level gage in the vicinity of the project areas was investigated to obtain data for use in the hydraulic design analysis. The gage is located at Shell Beach, Louisiana, along Bayou Yscloskey near its intersection with the MRGO, and is identified as Water Elevation Station 85800.

Figure 3 shows historical water elevations for Shell Beach, near the project sites, corrected to NAVD 88. From the gage, annual mean sea level (MSL) at Shell Beach is 0.76 feet NAVD 88, however there is a strong seasonal variance. MSL from January through July is 0.61 feet NAVD 88 and MSL in September and October is 1.30 feet NAVD 88. The graph shows a seasonal variation in stage that reflects some of the annual variation of mean gulf elevations.

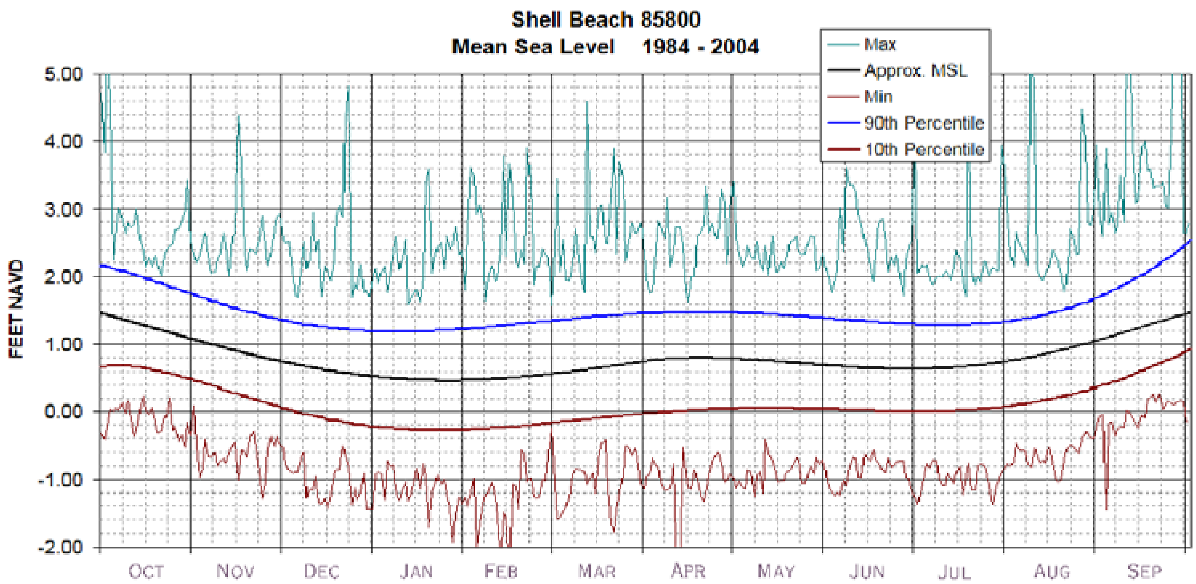

Figure 3. Mean Sea Level at Shell Beach Gage

The Coastal and Hydraulics Laboratory at Vicksburg, Mississippi reconstructed wind records from 1990 to 1999 for various stations along the Gulf coast. Wind data from station 142 at 29.83N 88.67W (70 miles east of Lake Borgne) shows that winds are about twice as likely to come from the east as from the west but that northerly and southerly winds occur about equally. High winds however, usually come from the north. The reconstructed maximum wind speed was 62.4 MPH at 64 degrees true. A statistical presentation of northerly wind speeds is shown in table 5. From these, a design wind equal to the 90th percentile speed of 24.2 MPH was chosen for this project.

Lake Borgne is relatively wide and shallow. With a 25-mile fetch and average depth of 9 feet, the expected wind setup from the maximum wind will be 5.5 feet. The setup from the 90th percentile wind is 0.9 feet using the Bretschneider equation and 0.5 feet using the Shell Beach gage historical data.[1] An average of these two measurements (0.7 feet) was used.

Using the Coastal Engineering Design and Analysis System (CEDAS) software, version 2.01g developed by personnel at the Waterways Experiment Station in Vicksburg, Mississippi and at Veri-Tech, the corresponding maximum wave height was found to be 3.0 feet.

[1] Project area water level data was analyzed for wind-induced surge or computed separately using the Bretschneider equation from USACE data at Lake Okeechobee (Bretschneider 1966).

Table 5. North Winds and Waves at Lake Borgne, Louisiana*

Percent Less Than	Wind Meters/Sec	Wind Miles/Hr	Waves CM	Waves Feet	Setup CM	Setup Feet
MAX	27.9	62.4	122	7.0	168	5.5
95%	12.0	26.8	67	3.6	34	1.1
90%	10.8	24.2	64	3.0	27	0.9
75%	9.0	20.1	55	2.3	18	0.6
50%	6.6	14.8	43	1.4	12	0.4
25%	4.5	10.1	31	0.8	6	0.2

* From 300^o to 60^o

The wind field was transferred from 70 miles offshore without any reduction for terrestrial friction and is very likely higher than what might be expected over Lake Borgne. The data table consists of 88,627 entries with only the winds from 300^o to 60^o being used to compute the 90th percentile design wind suggested in the report. A narrower range from say 10^o to 30^o would have produced slightly higher winds. A broader range would have produced lower winds as shown in the comparative **table 6** below. Our selection criterion was a reasonably high wind that is typical of the area.

Table 6. Wind Direction and Velocity Comparisons

	ALL WINDS			**WINDS FROM 300^o – 60^o**			**WINDS FROM 10^o - 30^o**	
	Wind			Wind			Wind	
	Meters /Sec	Miles/ Hr		Meters/ Sec	Miles/Hr		Meters/Sec	Miles /Hr
MAX	27.9	62.4	MAX	27.9	62.4	MAX	22.4	50.1
95%	11.0	24.6	95%	12.0	26.8	95%	12.2	27.3
90%	9.8	21.9	90%	10.8	24.2	90%	11.0	24.6
75%	7.8	17.4	75%	9.0	20.1	75%	9.4	21.0
50%	5.8	13.0	50%	6.6	14.8	50%	7.2	16.1
25%	4.2	9.4	25%	4.5	10.1	25%	4.9	11.0
10%	3.0	6.7	10%	3.1	6.9	10%	3.3	7.4
5%	2.4	5.4	5%	2.4	5.4	5%	2.6	5.8
MIN	0.2	0.4	MIN	0.2	0.4	MIN	0.2	0.4

Breakwater stone weight can be computed using Hudson's equation:

$$W_{50} = \frac{\gamma_r H^3}{K_D\left(\frac{\gamma_r}{\gamma_w} - 1\right)^3 \cot\theta}$$

where: γ_r = unit weight of rock, 155 lbs/cubic feet
γ_w = unit weight of water, 64 lbs/cubic feet
H = height of design wave, 2.1 feet
$\cot\theta$ = slope of rock, 1.5h:1v
K_D = stability coefficient, 2.41

which yields a mean rock size of 138 pounds. Stone with a mean size of 138 pounds are on the lower edge of the CEMVD standard for 24-inch riprap. Even though 24-inch riprap meets the minimum requirements, it was decided for economy of scale to use 36-inch riprap for the Lake Borgne dike.

The top elevation of the construction lift of the breakwater along Lake Borgne should be set as follows:

Mean water elevation	0.80 ft NAVD 88 (Shell Beach gage)
Wind setup (90%)	(0.5+0.9)/2 = 0.7 feet
Wave height (90%)	(3.0/2) = 1.5 feet
Future settlement (construction lift)	1.0 feet .
Top of breakwater	+4.0 feet NAVD 88

Engineer Manual 1110-2-1601, section 3-3, recommends that rubble-mound breakwaters have face slopes of no more than 1v:1.5h. Top widths of one stone diameter have been built but they were usually made of very large rock. To reduce damage from waves larger than the 90% design wave, the top width should be at least two stone diameters. There is concern, but no empirical evidence supporting the need for scour protection on the lakeside of the breakwater. Engineer Manual 1110-2-1614, section 2-19, suggests making the blanket thickness equal to the incident wave height and the width equal to about 3.5 times the thickness. However, the design team has considered the immediate displacement of soils during construction, the 5-foot crown width and the rapid initial settlement, and has recommended that the design section not include a berm.

Recommended Plan

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.
- Construct 15 miles of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

MRGO Bank Breakwaters.

The designs presented in the Section 206 Preliminary Restoration Plan for South Shores of Lake Borgne, Louisiana and the CWPPRA PO-32 Lake Borgne – MRGO Shoreline Protection were used. The proposed dike is aligned along the –2 ft. contour. The crown width is 5 feet and the top is set at elevation +4.0 ft NGVD. The dike is 6 feet high with a 5-foot wide crown and 1V on 2H side slopes. Similar designs are being considered for a CWPPRA project in the area that is in the preconstruction engineering and design phase.

Lake Borgne Breakwaters

The designs presented in the Section 206 Preliminary Restoration Plan for South Shores of Lake Borgne, Louisiana were used. The proposed dike is aligned along the –2 ft. contour. The crown width is 5 feet and the top is at +4.0 ft NGVD. The dike has 1V on 2H side slopes.

Additional Ecosystem Restoration Study

Details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the Modification of the Existing Structures portion of the LCA proposed authorization. Under this approach, the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Input from area residents, resource managers, Federal and state agencies, and USACE personnel have identified a number of options that could produce ecosystem benefits under a modification scenario. These options include marsh creation using dredged sediments, freshwater introduction to maintain salinity gradients, barrier island reconstruction and protection, and constriction of the MRGO channel. The ecosystem restoration measures would follow the strategies identified in the Coast 2050 Plan.

Alternatives for protecting ecosystem components have been evaluated in previous studies of projects in the area. These studies were conducted as part the CWPPRA program. The restoration plan developed by the Louisiana Coastal Wetlands Conservation and Restoration Task Force calls for protecting the shorelines of Lake Borgne and the MRGO from ongoing erosion. Various projects to protect segments of the lake shoreline and MRGO banks were included on the annual priority project lists for the program in 2000, 2002, and 2003. These projects are currently in the preconstruction engineering and design phase. Additional alternatives were identified in the Coast 2050 Plan and other suggestions for shoreline protection actions continue to be recommended during public meetings hosted by the Louisiana Coastal Wetlands Conservation and Restoration Task Force.

Benefits

Benefits to the environment resulting from this recommended critical action plan are particularly important to system integrity. Specifically, the bankline erosion rate, along both sides of the navigation channel, continues at an extremely high rate that requires immediate attention (see table 1). Although operation and maintenance of the navigation channel includes bankline stabilization, this task is executed primarily to reduce future maintenance dredging activities by reducing the amount of material sloughing off of the bankline and shoaling in the navigation channel. However, there are instances where bankline stabilization provides a containment barrier for the placement of dredged material for the purposes of wetland nourishment or creation in proximity to the navigation channel.

The benefits of the proposed shoreline protection features include:

- preserving large amounts of wetlands designated as Essential Fish Habitat,
- protecting critical habitat in Lake Borgne for the Federally-listed threatened Gulf sturgeon,
- avoiding significantly higher long-term restoration costs,
- protecting critical infrastructure (pipelines and oil and gas wells),
- storm surge buffering, and
- providing opportunities for value-added wetland restoration in conjunction with other ongoing programs (CWPPRA and O&M).

Another method of calculating benefits is the Wetlands Valuation Assessment (WVA). The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program has conducted WVAs for the PO-30/31 and PO-32 projects. These projects are designed to protect segments of shoreline along the southern rim of Lake Borgne and along the north bank of the MRGO. Specifically, the PO-30/31 project would construct breakwaters to protect Lake Borgne shoreline segments near Shell Beach and Bayou Dupre and the PO-32 project will protect several miles of the MRGO north bank and the southern shore of Lake Borgne between Doullut's Canal and Jahncke's Ditch. The WVA is a comparative differential model that produces benefit estimates in units known as Average Annual Habitat Units (AAHU).

For CWPPRA projects the period of evaluation for a WVA is twenty years. The CWPPRA PO-31a project is in the advanced stages of design for a 17,700-foot breakwater in Lake Borgne that would generate 73 AAHUs over twenty years. The PO-31b project is in the advanced stages of design for a 14,784-foot breakwater in Lake Borgne that would generate 29 AAHUs over twenty years. The CWPPRA PO-32 project is in the advanced stages of design for an 18,500-foot breakwater in Lake Borgne and 14,250-foot breakwater along the MRGO that combined would generate 70 AAHUs over twenty years. These estimates were used to generate reliable estimates of the AAHUs that would be generated by the proposed MRGO features of the LCA report. Converting shoreline lengths to miles and then dividing by the number of project AAHUs produces an estimate of AAHUs per mile. Combined the three projects have an average benefit of 13.9 AAHUs per mile. Applying this number to the proposed LCA feature generates 528 AAHUs over twenty years.

By stopping shoreline erosion, the feature would benefit approximately 100 acres per year along the MRGO channel and an additional 27 acres per year along the southern shoreline of Lake Borgne producing an estimated 528 AAHU. In addition, several critical points along both the channel and lake shoreline are threatening to breach in the near-term and could result in rapid acceleration of interior marsh loss. Over the next 50 years, the feature would protect approximately 6,350 acres of wetlands that are threatened from shoreline erosion along the MRGO and the lake.

Also, the features of the near-term plan for MRGO have been evaluated in the context of other ecosystem restoration needs in the area and across the greater coast and found to be consistent with the goals of the overall plan. Further, the features are deemed critical for the near-term success of the plan because of high benefits and the protection of important structural components of the surrounding estuaries.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. O&M costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The project designs were based on conventional and proven existing designs and/or supplemented with engineering experience. Shoreline protection was estimated based on conventional stone structures. Bank protection design was based on the MRGO North Bank foreshore dike designs. Measure lengths were developed by sketching in preliminary alignments atop Digital Ortho-Quarter-Quad (DOQQ) image files using MicroStation I/RAS C image processing software and measuring the feature lengths.

The area was divided into reaches and geotechnical estimates of construction losses for each reach were provided. **Table 7** shows measure, estimated length, and the construction losses used for estimating purposes.

Table 7. Assumed Length and Construction Loss for Measures

Measure	Linear Feet	Construction Loss
Lake Borgne/MRGO Land Bridge	89,000	40%
MRGO North Bank Mile 56.0 to 60.0	21,120	40%
MRGO North Bank Mile 50.9(51.1) to 49.8(49.5)	5,808	40%
MRGO North Bank Mile 48.5(48.5) to 44.9(44.9)	19,008	40%
North Bank Mile 36.5(36.5) to 36.1 and Mile 35.5 to 33.9(33.8)	10,560	40%
North Bank Mile 32.5(32.6) to 26.7	30,624	40%
North Bank Mile 24.4 to 23.2	6,336	40%

Feature costs are based upon completed construction of similar projects funded under the New Orleans District's channel O&M maintenance program. Approximately 12 miles of rock breakwaters were constructed under this program as part of a best management plan for channel maintenance dredging. Experience documented in the construction completion reports and the as-built surveys of those projects has been valuable for the design of other similar projects in the area.

Additional cost information has been developed from ongoing preconstruction engineering and design work conducted in the CWPPRA for a rock breakwater project located near Shell Beach, Louisiana. Information from these design and construction efforts indicates that rock breakwaters constructed for shoreline protection range from $1 million to $4 million per mile depending upon soil conditions and other site specifics.

These features would prevent the loss of 6,350 acres of marsh over the next 50 years. The estimated cost for designing and constructing critical rock breakwaters along the MRGO and selected sections of the southern Lake Borgne shoreline is $108.27 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 8. MCACES Cost Estimate, MRGO Environmental Restoration

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands and Damages (Includes Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01B30	By Govt on Behalf of LS				1,264,503	632,323	1,896,826
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				62,000	31,000	93,000
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				175,200	87,600	262,800
01E50	Review of LS				58,400	29,200	87,600
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G10	By Government				87,934	43,970	131,904
01N00	Facility/Utility Relocations (Subordination Agreement)				1,080	540	1,620
01R	Real Estate Payments						
01R1	Land Payments						
01R1C	By Govt on Behalf of LS				1,095,000	547,500	1,642,500
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				8,650	4,330	12,980
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				10,450	5,230	15,680
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				22,500	11,250	33,750
01--	Subtotal: Lands And Damages (Includes Influence Area)						2,809,277
	Contingencies						1,404,723
01--	Subtotal: Lands And Damages (Includes Influence Area)						4,214,000
01--	TOTAL: LANDS AND DAMAGES						
16--	BANK STABILIZATION						
16--	Lake Borgne/MRGO Land bridge						
	Mob and Demob	3	EA	70,000	210,000	73,500	283,500
	Stone (2,200 lb max.)	710,000	TN	26	18,460,000	6,461,000	24,921,000
	Core Material	260,000	CY	35	9,100,000	3,185,000	12,285,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Geotextile	770,000	SY	2.50	1,925,000	654,500	2,579,500
	Marker Plates	1,900	EA	500	950,000	323,000	1,273,000
	Flotation Channel	1	LS	1,112,500	1,112,500	378,500	1,491,000
16--	Subtotal: Lake Borgne/MRGO Land bridge						31,757,500
	Contingencies						11,075,500
16--	Subtotal: Lake Borgne/MRGO Land bridge						42,833,000
16--	North Bank Mile 50.9 (51.1) to 49.8 (49.5)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	31,000	TN	26	806,000	282,100	1,088,100
	Core Material	7,000	CY	35	245,000	85,750	330,750
	Geotextile	42,000	SY	2.50	105,000	36,750	141,750
	Marker Plates	70	EA	5000	35,000	12,250	47,250
	Flotation Channel	1	LS	76,250	76,250	26,400	102,650
16--	Subtotal: North Bank Mile 50.9 (51.1) to 49.8 (49.5)						1,337,250
	Contingencies						467,750
16--	Subtotal: North Bank Mile 50.9 (51.1) to 49.8 (49.5)						1,805,000
16--	North Bank Mile 48.5 (48.5) to 44.9 (44.9)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	94,000	TN	260	2,444,000	855,500	3,299,500
	Core Material	40,000	CY	35	1,400,000	490,000	1,890,000
	Geotextile	174,000	SY	2.50	435,000	152,250	587,250
	Marker Plates	390	EA	500	195,000	68,250	263,250
	Flotation Channel	1	LS	250,000	250,000	87,500	337,500
16--	Subtotal: North Bank Mile 48.5(48.5) to 44.9 (44.9)						4,794,000
	Contingencies						1,678,000
16--	Subtotal: North Bank Mile 48.5(48.5) to 44.9 (44.9)						6,472,000
16--	North Bank Mile 39.9 (39.9) to 37.2 (37.2)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Stone (2,200 lb max.)	71,000	TN	26	1,846,000	646,000	2,492,000
	Core Material	30,000	CY	35	1,050,000	367,500	1,417,500
	Geotextile	131,000	SY	2.50	327,500	114,625	442,125
	Marker Plates	290	EA	500	145,000	50,750	195,750
	Flotation Channel	1	LS	187,500	187,500	65,625	253,125
16--	Subtotal: North Bank Mile 39.9 (39.9) to 37.2 (37.2)						3,626,000
	Contingencies						1,269,000
16--	Subtotal: North Bank Mile 39.9 (39.9) to 37.2 (37.2)						4,895,000
16--	North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	51,000	TN	26	1,326,000	464,437	1,790,437
	Core Material	22,000	CY	35	770,000	269,500	1,039,500
	Geotextile	95,000	SY	2.50	237,500	83,125	320,625
	Marker Plates	220	EA	500	110,000	38,500	148,500
	Flotation Channel	1	LS	146,250	146,250	51,188	197,438
16--	Subtotal: North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						2,659,750
	Contingencies						931,250
16--	Subtotal: North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						3,591,000
16--	North Bank Mile 32.5 (32.6) to 26.7						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	151,000	TN	26	3,926,000	1,379,250	5,305,250
	Core Material	65,000	CY	35	2,275,000	796,250	3,071,250
	Geotextile	280,000	SY	2.50	700,000	245,000	945,000
	Marker Plates	620	EA	500	310,000	108,500	418,500
	Flotation Channel	1	LS	410,000	410,000	143,500	553,500
16--	Subtotal: North Bank Mile 32.5 (32.6) to 26.7						7,691,000
	Contingencies						2,697,000
16--	Subtotal: North Bank Mile 32.5 (32.6) to 26.7						10,388,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
16--	North Bank Mile 24.4 to 23.2						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	39,000	TN	26	1,014,000	344,887	1,358,887
	Core Material	17,000	CY	35	595,000	202,300	797,300
	Geotextile	73,000	SY	2.50	182,500	63,875	246,375
	Marker Plates	160	EA	500	80,000	28,000	108,000
	Flotation Channel	1	LS	76,250	76,250	26,688	102,938
16--	Subtotal: North Bank Mile 24.4 to 23.2						2,017,750
	Contingencies						690,250
16--	Subtotal: North Bank Mile 24.4 to 23.2						2,708,000
16--	North Bank Mile 56.0 to 60.0						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	102,000	TN	26	2,652,000	901,680	3,553,680
	Core Material	52,000	CY	35	1,820,000	618,800	2,438,800
	Geotextile	165,000	SY	2.50	412,500	143,645	556,145
	Marker Plates	430	EA	500	215,000	75,250	290,250
	Flotation Channel	1	LS	277,500	277,500	97,125	374,625
16--	Subtotal: North Bank Mile 56.0 to 60.0						5,447,000
	Contingencies						1,861,000
16--	Subtotal: North Bank Mile 56.0 to 60.0						7,308,000
16--	TOTAL: BANK STABILIZATION						80,000,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				4,500,000	900,000	5,400,000
	PED				3,000,000	600,000	3,600,000
	E&D				3,840,000	774,000	4,614,000
	Monitoring				842,000	170,000	1,012,000
30--	Subtotal: Engineering And Design						12,182,000
	Contingencies						2,444,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
30--	TOTAL: ENGINEERING AND DESIGN						14,626,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				8,000,000	1,600,000	9,600,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						9,600,000
	TOTAL PROJECT COST						108,270,000

Monitoring the performance of project features will be conducted as part of the construction portion of the plan. The purpose of including monitoring in the project is to document the performance of the structures in terms of meeting the goals of the environmental project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the rate of subsidence of the rock breakwaters constructed. This rate will vary depending upon the specific subsurface soil conditions along the alignments. Typical O&M actions will include engineering inspections of the breakwaters and construction events to maintain the necessary elevations to stop shoreline erosion. These Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) actions will be the responsibility of the local sponsor. The estimated average annual O&M cost is $711,000.

Table 9 provides a summary of the first costs for the initial phase of the MRGO Environmental Restoration Features project.

Table 9. Summary of Costs for the LCA Plan

MRGO Environmental Restoration Features (June 2004 Price Level)		
Lands and Damages	$	4,214,000
Elements:		
Bank Stabilization	$	80,000,000
Monitoring	$	842,000
First Cost	$	85,056,000
Feasibility-Level Decision Document	$	5,400,000
Preconstruction Engineering, and Design (PED)	$	3,600,000
Engineering, and Design (E&D)	$	4,614,000
Supervision and Administration (S&A)	$	9,600,000
Total Cost	$	108,270,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 10**.

Table 10. MRGO Environmental Restoration Features

FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 2,700,000	$ 2,700,000	$ 5,400,000
PED (65%Fed-35%NFS)	$ 2,340,000	$ 1,260,000	$ 3,600,000
LERR&D (100% NFS)	$ -	$ 4,214,000	$ 4,214,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 54,739,100	$ 25,260,900	$ 80,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 2,999,100	$ 1,614,900	$ 4,614,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 6,240,000	$ 3,360,000	$ 9,600,000
Monitoring (65%Fed-35%NFS)	$ 547,300	$ 294,700	$ 842,000
Total Construction	**$ 66,865,500**	**$ 36,004,500**	**$ 102,870,000**
TOTAL COST	**$ 69,565,500**	**$ 38,704,500**	**$ 108,270,000**
Cash Contribution	*$ 69,565,500*	*$ 31,790,500*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the MRGO environmental restoration features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor, Louisiana Department of Natural Resources (LDNR), as well as, detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in January 2005, with completion estimated in two years (January 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and ready the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule and cost of the design. Preparations of plans and specifications for construction could commence in January 2007 and are forecasted for completion in two years (January 2009). Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as January 2009, with construction completion estimated for the end of calendar year 2012.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable and that a high degree of coordination and funding will be required to achieve the goals and objectives of the plan and address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

Since early 1999, there has been considerable public and agency involvement and input concerning the future of the MRGO through the efforts of the U.S. Environmental Protection Agency (USEPA), and others. The USEPA and the LDNR sponsored an effort to plan for the "Timely Modification of the MRGO." To that goal, committees composed of representatives from government agencies, local governments, environmental groups, and shipping interests have met on numerous occasions to discuss and plan for modifications to the MRGO. These efforts have assisted in preparation of alternatives descriptions and NEPA documentation.

A notice of intent to prepare an Environmental Impact Statement (EIS) for an MRGO reevaluation study was published in the *Federal Register* on Tuesday, August 7, 2001. Scoping meetings were held on August 30, 2001, in Chalmette, Louisiana, and on September 5, 2001, in New Orleans, Louisiana. A draft EIS is being prepared to accompany the draft reevaluation study report. The draft General Reevaluation Study report is scheduled for submittal to USACE-Mississippi Valley Division for review in late calendar year 2004.

A draft Environmental Assessment for the CWPPRA-sponsored "Lake Borgne – Mississippi River Gulf Outlet Shoreline Protection" was released for public comment in September 2004. The document outlines plans and impacts for two proposed rock breakwaters along segments of lake and channel shoreline for the purposes of preventing wetlands erosion.

Special provisions in the draft EA have been incorporated into project designs and construction plans to protect threatened and endangered species and to conserve estuarine fish habitat.

The environmental impacts of the near-term features recommended in the LCA authorization are covered in the Programmatic Environmental Impact Statement (PEIS) for the study. In addition, each specific project recommended will proceed through feasibility study for approval requiring project specific review under NEPA through a Supplemental Environmental Impact Statement (SEIS) or Environmental Assessment (EA). These environmental compliance actions will be completed in decision documents to be reviewed and approved by the Secretary of the Army.

During the plan formulation process the LCA Project Delivery Team assessed the impacts of various specific restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the tentatively selected plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plans carried over for detailed analysis. The PEIS provided a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

Previous efforts to protect eroding shorelines have successfully utilized rock breakwaters along the MRGO to prevent marsh loss. However, extremely poor soil conditions in the project area require high cost O&M events to maintain the level of protection from large vessel wakes and high-energy storm and wind-driven waves. Detailed engineering investigations help reduce the risk associated with constructing and maintaining rock dikes in areas of poor soil conditions. In addition, some promise exists from demonstrations in the area of alternative shoreline protection methods. These methods may allow more cost-effective solutions to the high rates of shoreline erosion in the area. Feasibility level investigations will produce detailed designs that recognize these limitations and opportunities and recommend the appropriate solutions to the ongoing shoreline erosion problems in the area. In general, project design risks are considered minimal and likely to be reduced even further with the conduct and completion of feasibility investigations and detailed engineering and design work.

Subject to Feasibility

The most important area of uncertainty associated with the near-term proposal is the future of the MRGO navigation channel as a deep-draft shipping route. A study is currently underway to reevaluate the economic benefits to the Nation of maintaining the channel. The scope of the reevaluation study covers a number of different alternative depth modifications and implementation timeframes for channel authorization changes. The outcome of that study has not been determined and, thus, the future status of the channel is unknown at this time. The possibility exists that some time in the future the status of the channel could be changed through a USACE study recommendation and a Congressional action to deauthorize the shipping canal.

However, while some of the ecosystem losses occurring in the area are directly associated with the operation of the navigation channel, the need for shoreline protection on Lake Borgne and the channel will remain regardless of the future status of the channel. The need will remain because the background factors in Louisiana wetland losses will continue and some shallow-draft navigation will likely continue to use the area waterways. The completion of the channel reevaluation study and the undertaking of the feasibility investigations for the near-term measures will require close coordination because of the interrelation of the matters.

Contingent Authorization/Demos/S&T

Protecting critical ecosystem structural components in the area will provide extensive direct and indirect benefits. Several opportunities exist to investigate potential alternative designs and techniques to improve project performance and cost effectiveness. Certain advanced geotechnical improvement technologies are being used throughout the world to build structures in poor soil settings. The application of these advanced engineering methods to restoration plans could produce better project performance for rock breakwaters built in the coastal wetlands of Louisiana. In particular, these methods could produce substantial cost savings in the MRGO area through the reduction of O&M requirements associated with the construction losses, subsidence and settlement of the breakwaters. Investigation of these engineering methods for application to MRGO environmental restoration could involve the construction of test sections to evaluate project performance improvements. These test sections would demonstrate the effectiveness of the engineering improvements and would identify technologies for broader application in this environmental restoration effort.

Recommendations/Summary

The Lake Borgne estuarine complex is deteriorating and recent analysis indicates that the rate of wetland loss in the area is accelerating. Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and to prevent continued erosion of the MRGO channel banks from ocean going vessel wakes. Additional ecosystem restoration features are required to address serious ecological problems developing in the surrounding parts of the estuary. Without action, critical landscape components that make up the Lake Borgne estuary would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive if not impossible.

While the MRGO Environmental Restoration Features were not specifically evaluated for cost-effectiveness, it was found to be a critical feature of seven feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need for restoration. It is recommended for implementation based on the sequencing rule that identifies features at potential risk for loss of opportunity if near-term action is not taken. The identification of critical ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. However, in this case, action now will save critical structural components of the estuary that cannot be replaced if they are lost.

Critical action points to avoid near-term (3 to 5 years) threats of shoreline and bayou breaches are located at Bayou Bienvenue, Bayou Mercier, Proctor Point, Alligator Point, Bayou Biloxi, Bayou Magill, and Antonio's Lagoon. These sites face significant risk of losing the integrity of bayou banks along the lake shoreline and a potential major breach of the navigation channel into the lake. Loss of bayou bankline stability would result in higher rates of erosion and destruction of limited and diverse habitats that offer fish and wildlife refuge from open lake conditions. A breach between the lake and the MRGO navigation channel would result in rapid wetlands loss as storm waves from the lake and ship wakes from the channel impact sensitive interior wetlands and submerged grass beds in protected ponds. Further impacts from breaches would occur as scarce sediments are exported into deeper water and out of the wetland system.

This critical restoration feature proposes to construct 23 miles of rock breakwaters along the north bank of the MRGO and 15 miles along important segments of the southern shoreline of Lake Borgne that are projected to breach in the near future. Strategic placement of similar protective breakwaters has been effectively used along the MRGO to prevent shoreline retreat. Under this plan, large amounts of estuarine marshes would be protected from further shoreline erosion and other areas would be improved for the long-term benefit of the environment. In addition, other restoration features will be investigated that produce environmental benefits following the sequence established in the Coast 2050 plan to preserve wetlands and maintain the estuarine gradients established by the surrounding marshes. These habitats are significant for commercial and recreational fisheries as well as wildlife, and these areas serve as critical habitat for the threatened Gulf sturgeon.

Finally, details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the modification of existing structures portion of the LCA proposed authorization. Under this approach the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Small Diversion at Hope Canal

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Small Diversion at Hope Canal
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The Maurepas Swamp is an area of considerable ecological, socio-economic, and cultural importance. Since the construction of the Mississippi River flood control levees, large portions of the Maurepas Swamp have largely been cut off from freshwater, sediments, and nutrients. Due to this disruption in natural processes, soil building in the swamp has been insufficient to keep up with subsidence. Consequently, much of the swamp is persistently flooded, the existing trees are highly stressed, and there is little to no natural regeneration of cypress and tupelo trees, which are the dominant vegetation in this swamp ecosystem. These factors, combined with increasing occurrences of high salinities, have resulted in a highly degraded swamp system, which is at great risk of conversion to open water.

The Hope Canal project would reintroduce 1,000 to 2,000 cubic feet per second (cfs) of Mississippi River water into the southern portion of the Maurepas Swamp, thereby increasing the flow of freshwater, nutrients, and fine-grained sediment to an area in the swamp that is highly stressed and in need of restoration. The Hope Canal project is fully consistent with both the strategies used to develop the draft LCA restoration plan and the critical needs criteria for identifying near-term restoration opportunities.

The purpose of the Hope Canal project is to restore and protect the health and productivity of the swamps south of Lake Maurepas through reintroduction of Mississippi River water. The specific objectives of the project concept are to:

- Prevent habitat conversion and land loss;
- Restore and maintain characteristics of natural swamp hydrology;
- Retain and preferably increase overstory cover;
- Decrease the mortality rate of tupelo trees;
- Increase the primary productivity of trees;
- Reduce salinity levels in the swamp;
- Increase sediment loading to the swamp;
- Increase nutrient loading to the swamp;
- Increase dissolved oxygen concentrations in swamp water;
- Ensure that reintroduction of river water does not result in increased nuisance algal blooms in Lake Maurepas; and
- Reduce nutrient loading from the Mississippi River to the Gulf of Mexico.

Having undergone years of interagency and public review, the Hope Canal project is in a good position to move forward expeditiously within the LCA Plan. Since being selected by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Task Force as the "Mississippi River Reintroduction into Maurepas Swamp" in January 2002, for engineering and design work, the Hope Canal project has undergone considerable environmental and engineering review, including hydrologic modeling; baseline vegetation, soils, and water quality monitoring;

preliminary alternatives analysis; and environmental benefits assessment. A number of public hearings and outreach activities have also been conducted. Most recently, engineering and design and the National Environmental Policy Act (NEPA) process have been initiated as part of the ongoing CWPPRA process for this project. Some of the major actions conducted to date are:

- Channels (canals and bayous) have been surveyed.
- Swamp elevation data have been obtained.
- A one-dimensional hydrologic model (UNET) was developed, and existing conditions, various reintroduction options, and project features have been simulated.
- Water level data have been collected for over two years.
- Swamp vegetation has been characterized.
- Productivity (growth) of swamp trees and other vegetation has been measured for over two years.
- Sediment accumulation in the swamp has been measured for over two years.
- Nutrient concentrations in canals and bayous have been measured for two years.
- Alternative reintroduction alignments have been evaluated.
- Real estate and relocation costs have been estimated.
- LIDAR data (swamp elevation) have been acquired.
- Several public meetings have been held.
- Interagency coordination meetings on drainage issues have been held including EPA, USACE, St. John Parish, and their drainage master plan contractor.
- A cooperative agreement between EPA and the Louisiana Department of Natural Resources (LDNR) has been in place for over two years, supporting Phase 1 engineering and design work, including some of the above activities.

Description of Area/Background

The Maurepas Swamp is located in LCA Subprovince 1, west of Lake Pontchartrain and north of the I-10 corridor (**figure 1**). The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area is approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh.

The Maurepas Swamp is important habitat for a range of fish and wildlife species, including crawfish, alligator snapping turtles, blue crab, and channel catfish. The Maurepas Swamp also provides valuable habitat to a number of avian species, including neo-tropical migratory songbirds and waterfowl. Two threatened species (the bald eagle and Gulf sturgeon) are found in this area. Bald eagles typically nest in cypress trees near fresh to intermediate marshes or open water. There were 16 active and 7 inactive bald eagle nests in this area during the 2003-2004 breeding season. The Gulf sturgeon is a threatened species found in Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of cypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

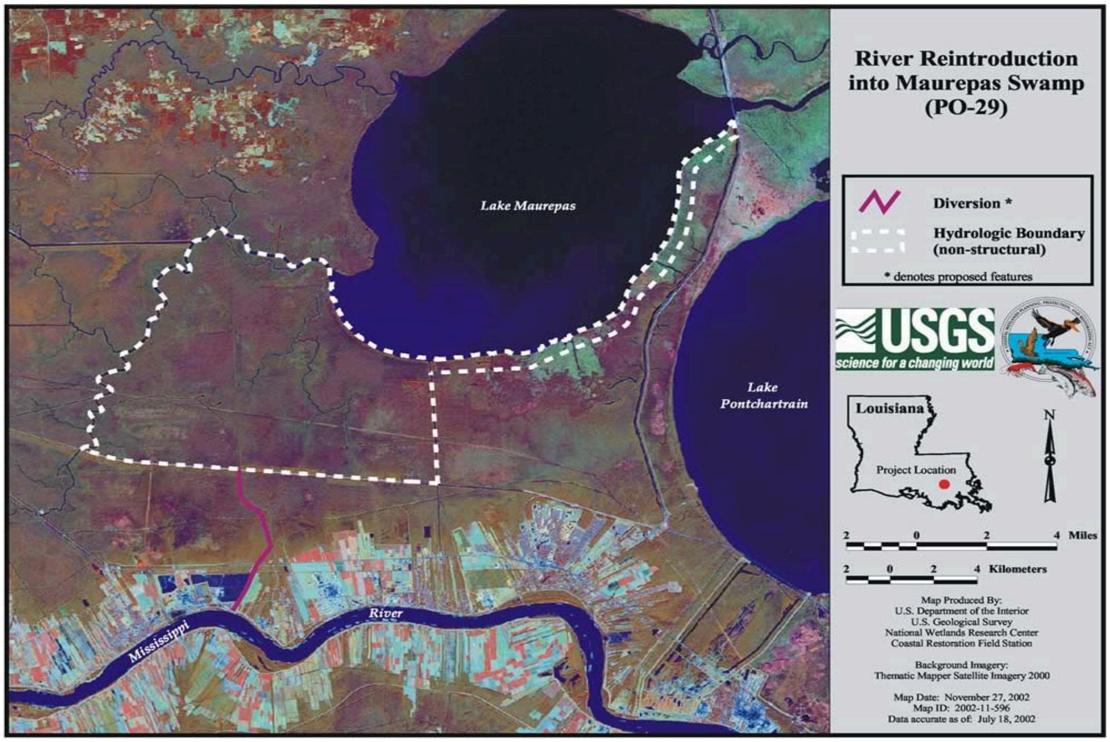

Figure 1. Map showing the general location of Maurepas Swamp, proposed Hope Canal conveyance route, and project hydrologic boundary.

Since the construction of the Mississippi River flood control levees, the Maurepas Swamp has been virtually cut off from any freshwater, sediment, and nutrient input. Thus, the only soil building has come from organic production within the wetlands, and vegetative productivity may be substantially depressed compared to normal conditions. Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, so that now the swamps are persistently inundated.

With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. However, neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede. The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks and by herbivory, as well as by flooding. Apparently, tupelo trees are more competitive in permanently flooded conditions, a condition that may explain the recent dominance of tupelo in the Maurepas Swamp. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas study area.

In addition, the existing trees are highly stressed, which decreases productivity, increases mortality, and increases susceptibility to herbivory and parasites. Saltwater intrusion has increased, at least in part due to a progressive combination of net subsidence and the lack of riverine freshwater inputs. Saltwater intrusion events observed in 1999 and 2000 caused greater than 97 percent mortality of tens of thousands of cypress seedlings planted in the northwestern portion of the Maurepas Swamp. Salinity can be an important factor contributing to swamp deterioration, especially combined with other stressors (e.g., flooding, herbivory). Herbivory appears to be another potentially important stressor in the Maurepas Swamp. Tupelo trees are susceptible to grazing by tent caterpillars and cypress by leaf rollers, which can result in almost total defoliation in the spring. Caterpillar grazing can reduce production of litter by about 13.5 percent. Young cypress and tupelo are both very susceptible to grazing by nutria, deer, and crawfish.

Problems and Needs

The combination of little to no tree regeneration and more frequent incidence of higher than tolerable salinities place the Maurepas Swamp at high risk of conversion to open water. Recent tropical storm events, occurring at a rate of one to two per year, have produced measurable spikes in salinity in the area. With subsidence, the lack of substrate accretion, and reduced organic productivity, this area is at high risk for the type of die-off that is already occurring in lake rim areas in western Lake Pontchartrain. With the increasing water depth in these areas, it is highly likely that swamp habitat will be converted to open water rather than intermediate marsh.

The ability to restore flows of Mississippi River waters to the Maurepas Swamp represents an important opportunity to respond to the restoration needs of this valuable and endangered coastal Louisiana wetland ecosystem. In addition to the ecosystem benefits the Hope Canal project could provide, there would also be indirect benefits such as an increased knowledge of swamp ecosystem restoration and the logistical and engineering aspects of river reintroduction projects. Capitalizing on this ecosystem restoration opportunity could increase the efficiency and effectiveness of subsequent reintroduction measures, particularly those dealing with swamp ecosystems.

Critical Need for the Project

The cypress-tupelo swamps south of Lake Maurepas represent an accumulation of decades of plant production and associated ecological complexity. Much (arguably, relatively more than even most other coastal ecosystems in Louisiana) will be lost if this ecosystem is degraded beyond the ability to restore it. Given the temporal considerations associated with replacing long-lived tree species, preventing the loss of such trees is preferable from both economic and ecological standpoints.

The ongoing degradation of the Maurepas Swamp can be attributed to two types of factors: the first being the relatively constant stress associated with the lack of riverine input and prolonged inundation, and the second being the effects of stochastic events, most notably increased salinities. A qualitative estimate of the ecosystem losses that could be prevented by contingent authorization must consider both types of these factors.

The ongoing, constant deterioration of the Maurepas Swamp results in reduced tree productivity and health, increased tree mortality, decreased soil integrity, and increased relative subsidence. At this same time, stochastic events (particularly salinity increases) have the potential to dramatically increase tree mortality, while further stressing the remaining trees. Delaying project implementation would result in a continuation of the constant ecosystem decline, while also exposing the existing ecosystem to the additional risks associated with increased salinities and other difficult to predict events. Therefore, under any scenario, expediting implementation of the Hope Canal project would prevent a range of potential adverse effects. Again, because the higher end of this range would represent unpredictable events, it would not be possible to accurately predict the full possible extent of such losses.

The potential adverse effects discussed above would include decreased habitat for important avian species (most notably the bald eagle), and could also adversely affect the populations of a variety of indigenous species, such as crawfish, alligator snapping turtles, blue crab, and channel catfish. Additionally, such losses would also contribute to an overall decline in swamp health, as measured by soil integrity, substrate elevation, and vegetative health and resilience.

The effectiveness of the Hope Canal project depends in large part upon enhancing the health and productivity of the existing trees, which would play a major role in restoring soil integrity and counteracting subsidence. As discussed above, delaying action on the Hope Canal project would result in increased tree mortality and decreased health in the remaining trees. It is very difficult to quantify the number of individual trees that would die or become severely stressed, but it is certain that the system as a whole will suffer without action. A delay would, therefore, most likely reduce the effectiveness of this restoration effort and/or require increased restoration inputs to achieve the same level of benefits.

Contingent authorization of the Hope Canal project is an appropriate and necessary way to meet the critical needs discussed above. Specifically, expediting the authorization process for this project has the potential to:

- Reduce tree mortality and decline in the overall health of the swamp;
- Minimize exposure to stochastic risks, particularly increased salinities;
- Reduce potential impacts to populations of indigenous fish and wildlife species; and
- Minimize restoration costs and maintain restoration effectiveness.

Much background work has been done on this project under the CWPPRA. However, funds under that authority are very limited and larger ecosystem type projects are more properly funded under the LCA.

Alternatives Analysis

The Small Diversion at Hope Canal project has been approved by, or is consistent with a number of major planning efforts for coastal Louisiana, including Coast 2050, CWPPRA priority project list (PPL) 11, and five of the seven cost-effective, coast wide restoration frameworks developed as part of the LCA process. In addition, the cost effectiveness/incremental cost analysis of the Mississippi River, Sediment, Nutrient, and Freshwater Redistribution Study identified a reintroduction (as large as 2,000 cfs) in the vicinity of Hope Canal as a cost-effective means of utilizing Mississippi River resources for restoration. Given this history, as well as the current LCA Plan, it is highly likely that the Hope Canal project would be a component of any comprehensive plan developed in the future.

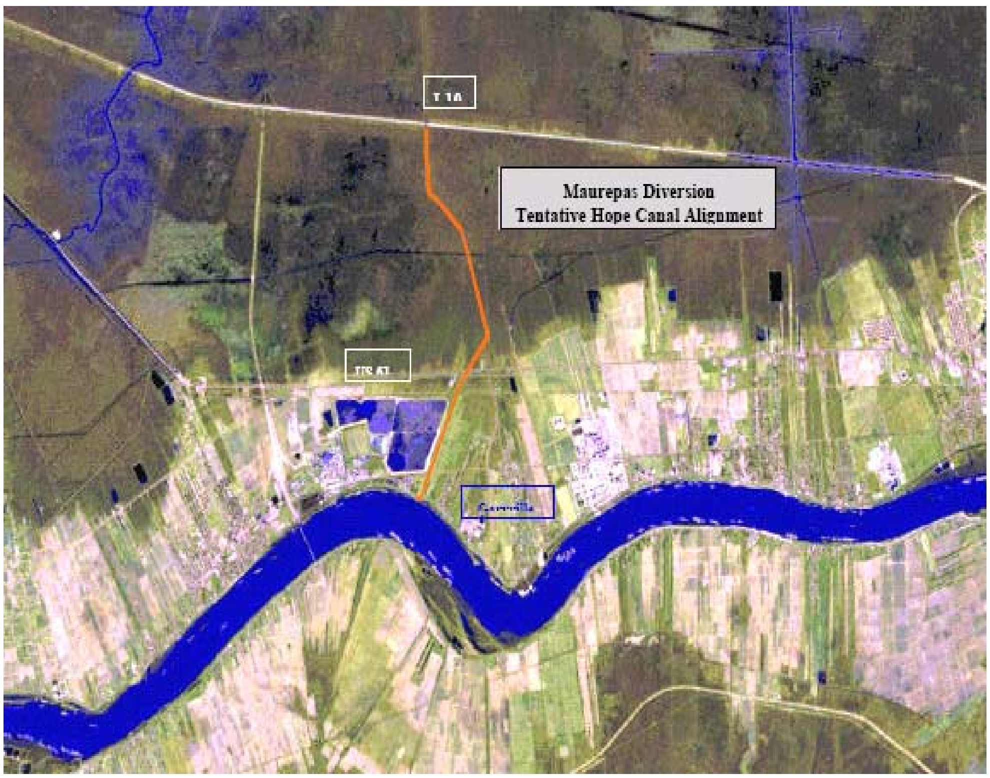

Figure 2. Proposed Hope Canal alignment.

In addition to the studies and planning efforts referenced above, a preliminary alternatives analysis has been conducted under the CWPPRA process. This alternatives analysis reviewed four different locations (or conveyances) for reintroduction of Mississippi River water into the Maurepas Swamp. The four reintroduction locations reviewed were Reserve Relief Canal, Hope Canal, Convent, and Romeville. The alternatives analysis examined major factors that are either important to imparting benefits to the swamp or to avoiding unacceptable human conflicts or excessive costs, including any potentially irresolvable conflicts that could represent “fatal flaws” to project implementation.

While not necessarily eliminating other alternatives as potentially suitable options, the alternatives analysis indicated that Hope Canal provides distinct advantages with respect to cost, logistics, complexity, and potential environmental benefits. In short, Hope Canal was found to be the most promising alternative. Among other advantages, it was found that the Hope Canal site is located such that water reintroduced there has the potential to flow directly into the swamps where benefits are needed, while at the same time minimizing potential conflicts with the existing development. The proposed conveyance channel would traverse largely undeveloped land, thereby reducing conflict with existing development. Additionally, the dimensions of the existing channel north of I-10 is a benefit, as it facilitates outfall management and maximizes the amount of diverted water that would be introduced into sheet-flow through the swamp. (**table 1** provides a summary of the preliminary analysis of alternative reintroduction sites with respect to potential swamp benefits.)

Table 1. Alternative Reintroduction Sites

	Sites			
Issue	**Romeville**	**Convent**	**Hope Canal**	**Reserve Relief Canal**
Distribution of Diverted Water Through Swamp	Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.	Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.	Easiest to manage for complete overland flow of diverted water, good network of channels for distribution through swamp. Require the least amount of outfall structures, thus less cost and interference with boat traffic.	Easier to get water out of canal than Blind River, but still expect primarily channel flow directly to lake; lesser network of channels for distribution than Hope Canal. Would require additional channel construction to direct water back to desired area of the swamp. This would add cost, interference with boat traffic.
Character of Target Swamps and Relative Benefits to Swamp Areas	Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.	Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.	Receiving swamp is stressed; some areas of moderately stressed swamps adjacent to Hope Canal at I-10, but large areas of highly stressed swamps near Tent and Mississippi Bayous. Greatest benefits, due to maximum distribution of diverted water through greatest area of needy swamp.	Relatively high level of stress in receiving swamps. Moderate benefits - not as easy to distribute diverted water as Hope Canal, slightly smaller area of target swamps.

It is important to note again that this alternatives analysis did not necessarily eliminate other alternatives as potential means for addressing environmental concerns in the Maurepas Swamp; rather, it suggests that Hope Canal offers the optimal first step in restoring the swamp. The Hope Canal project will not benefit the entire Maurepas Swamp; therefore, further restoration will be needed, particularly the other two measures included in the TSP (i.e., Amite River Diversion Canal and Small Diversion at Convent/Blind River).

The past and ongoing work described above has helped demonstrate the necessity, appropriateness, cost-effectiveness, and feasibility of the project, and can provide valuable information that would help expedite study and implementation under contingent authorization.

Recommended Plan

The selected project's main structural features will include 2 10-foot x 10-foot box culverts in the Mississippi River levee with the invert set at an elevation to assure capability of essentially year-round diversion (see **figure 2**). A receiving pond/settling basin with 100-foot x 100-foot dimensions, reinforced with 20 inches of riprap, would be built at the outfall of the culverts to slow velocities and remove heavy sand. It would be necessary to excavate a new leveed channel from the existing southern terminus of Hope Canal to the proposed reintroduction structure in the Mississippi River levee. Additionally, the cross section of Hope Canal would need to be enlarged to a width of 50 feet to accommodate the reintroduced river water. This channel would be a total of 27,500 feet long and run from the river to I-10. Outfall management would be necessary to insure the water gets over the swamp. There will be navigable constrictions in Hope Canal and an abandoned railroad embankment will be gapped along Hope Canal north of I-10. Results from a UNET model were used to develop the project features above.

The State of Louisiana represented by the LDNR will perform all operation and maintenance and rehabilitation. Operation and maintenance activities would consist of structure operation, channel maintenance, grass cutting, etc. No specific year is scheduled for rehabilitation at present time, but this will be determined during future engineering and design.

Monitoring

Water levels, salinity patterns, swamp productivity, accretion, nutrient assimilation and other associated responses will be monitored. The data from monitoring will be used to adaptively manage this project. Knowledge gained from monitoring will also be applied to the planning and operation of other reintroductions into swamps.

Synergy with Other Restoration Projects

Reintroduction of river water at Hope Canal would complement LCA near-term projects to restore other parts of the Maurepas Swamp (i.e., Small Diversion at Convent/Blind River and Amite River Diversion). Hope Canal would restore the lower end of the Maurepas swamp system while the other two projects would preserve the upper and central areas.

As noted above, implementation of the Hope Canal project would also provide indirect restoration benefits in terms of increased knowledge on the scientific and logistical aspects of river reintroduction, knowledge that would be valuable for future reintroduction projects. In particular, implementation of this reintroduction project would provide information that would further our understanding of cypress swamp restoration and would be useful to both the near-term Maurepas projects mentioned above as well as cypress swamps in the upper Barataria Basin (Subprovince 2).

Benefits

To preserve swamps in the long-term, conditions must be reestablished that both allow survival of existing cypress and tupelo trees and allow at least periodic reproduction and recruitment of seedlings. In the Maurepas Swamp, non-stagnant water, accretion, and freshening are all needed to achieve these goals. From the perspective of sustainable ecosystem management, it is believed that implementation of a reintroduction project of appropriate size into the Maurepas Swamp is essential for bringing the area back toward environmental sustainability. Implementation of the proposed reintroduction will greatly increase flow through the project area, which will provide constant renewal of oxygen- and nutrient-rich waters to the swamps. (It is important to note that the proposed alternative would be operated such that reintroductions are reduced or stopped when climate and soil conditions are conducive to tree regeneration.)

Benefits of the Hope Canal project will include measurable increases in productivity, which will help build swamp substrate and balance subsidence, as well as increases in growth of trees, reduced mortality, and an increase in soil bulk density. As accretion improves, there also is expected to be an increase in recruitment of new cypress and tupelo trees, required for long-term sustainability of the swamp. Anticipated sediment benefits to the swamp include direct contribution to accretion, as well as contribution to biological productivity through the introduction of sediment-associated nutrients, which also contributes to production of substrate. The sediment loading to the target swamps from the Hope Canal reintroduction is conservatively estimated to be >1,000 $g/m^2/yr$, or about twice the estimated quantity needed to keep up with subsidence.

Results of a CWPPRA "Phase 0" study show the Maurepas Swamp is almost certainly nutrient limited. Other studies provide the expectation that the addition of nutrients with diverted water would at least double growth rates of the dominant swamp trees. An important adjunct to this is that it is estimated that nutrients added with diverted river water would be essentially completely taken up within the swamp (i.e., prior to discharge to Lake Maurepas). The addition of nutrients and associated increase in production will contribute substantially to the buildup of swamp substrates (accretion) through organic contribution, which will help counterbalance subsidence. Therefore, nutrient additions will directly improve the health of the trees and conditions of the swamp, and in the long run also will help generate a condition more conducive to sprouting and recruitment of cypress and tupelo seedlings.

Previous study also shows the impacts of saltwater intrusion on the cypress-tupelo swamps, including mortalities of cypress, tupelo, red maple and ash, and suppression of tree productivity in the areas of highest salinity. Saltwater intrusion in the Maurepas Swamp is impacting swamp vegetation already stressed by excessive flooding. The proposed re-introduction project is expected to directly ameliorate increasing salinities in the Maurepas Swamp, as well as in the lake itself. This is expected to largely prevent the high mortalities previously observed in the project area. More persistently freshwater conditions are also expected to help increase tree and herbaceous productivity, which along with the flow-through of oxygen-, sediment- and nutrient-rich waters, will contribute to stronger (higher bulk density) substrates and increased accretion. Beyond direct benefits to the swamps, it is expected that there could be a positive indirect impact on Lake Maurepas freshwater fisheries, along with freshwater-related wildlife species.

The inner continental shelf of the Gulf of Mexico off Louisiana currently experiences widespread hypoxia (low dissolved oxygen conditions) during the summer, attributed to direct introduction of nutrient-rich water from the Mississippi River. It has been recommended that wetlands and shallow water bodies be used to process river water before it enters the Gulf, to reduce the magnitude of this hypoxic zone as well as help restore the wetlands. Nutrient studies conducted as part of the CWPPRA process show that approximately 94 percent to 99 percent of the nutrients introduced in diverted water will be processed and retained by the Maurepas Swamp. Therefore, it can be assumed that contribution of this Hope Canal project toward amelioration of Gulf hypoxia would be proportional to the magnitude of flow of the reintroduction compared to that of the Mississippi River. Because the volume of the proposed Maurepas reintroduction project is small compared to average flows in the river, by itself this reintroduction would not have a measurable impact on the size of the hypoxic zone. But the proposed reintroduction should be viewed as a functional component of a potentially larger system of river reintroductions that together could reduce nutrient delivery to the Gulf. It should be noted, however, that reintroductions alone could not solve the problem of Gulf hypoxia. It will be necessary to implement a suite of other measures designed to reduce nutrients at their sources, as well as to implement similar riverine wetland restoration efforts throughout the Mississippi/Atchafalaya River Basin.

WVA Benefits

The procedure for evaluating the benefits of CWPPRA projects to swamp habitats, the Wetland Value Assessment (WVA) swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are estimated for existing condition,; conditions projected into the future if no restoration efforts are applied, and conditions projected into the future if the proposed diversion project is implemented. This procedure provides an index of "quality" of the swamp for the given time period. The quality index is then combined with the acres of swamp to get a number that is referred to as "habitat units." Expected project benefits are estimated as the difference in habitat units between the futures with and without the project. To allow comparison of WVA benefits to costs, total benefits are averaged over a 20-year period, with the result reported as Average Annual Habitat Units (AAHUs).

The Hope Canal project would restore approximately 36,000 acres of swamp. The total WVA benefits estimated for the project are 8,486 AAHUs, which is the highest estimated AAHU score for any CWPPRA project to date.

It is important to note that the CWPPRA institutional constraint of considering project benefits only over 20 years is widely understood to underestimate benefits in a swamp because cypress and tupelo trees are very long-lived, and their response (positively or negatively) to environmental change may take many decades to be realized. In particular, a diversion now could prevent catastrophic loss of swamp areas 30 or 40 years in the future. Thus, the merits of a reintroduction into the Maurepas Swamp have probably been underestimated and the above estimates provide a very conservative measure of the expected outputs over the 50-year period-of-analysis.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The estimated cost for designing and constructing the river reintroduction at Hope Canal is $70.513 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 2. MCACES Cost Estimate, Hope Canal (Maurepas Swamp) Diversion

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands And Damages (Including Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500
01B30	By Govt on Behalf of LS				189,078	94,788	283,866
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				8,276	4,140	12,416
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				20,400	10,200	30,600
01E50	Review of LS				6,800	3,400	10,200
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				11,300	5,650	16,950

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G10	By Government				10,278	5,140	15,418
01N00	Facility/Utility Relocations (Subordination Agreement)				8,650	4,330	12,980
01R	Real Estate Payments						
01R1	Land Payments						
01R1C	By Govt on Behalf of LS				17,212,000	8,606,000	25,818,000
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				79,500	39,750	119,250
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction				2,000	1,000	3,000
51B	Real Estate Management Services				15,000	7,500	22,500
51B20	Outgrants (Over 5 Years)				10,000	5,000	15,000
51B30	Disposal/Quitclaim						
01--	Subtotal: Lands And Damages (Including Influence Area)						17,588,492
	Contingencies						8,794,508
01--	Subtotal: Lands And Damages (Including Influence Area)						26,383,000
01--	TOTAL: LANDS AND DAMAGES						26,383,000
02--	RELOCATIONS						
02--	Roads, Railroads, Utilities and Pipelines	Lump Sum	LS	20,349,000.00	20,349,000	2,035,000	22,384,000
02--	TOTAL: RELOCATIONS						22,384,000
09--	CHANNELS AND CANALS						
09--	Channels						
	Channel Work	1,032,300	CY	3.10	3,200,130	320,970	3,521,100
	Sediment Basin	Lump Sum	LS	549,000.00	549,000	54,900	603,900
	Subtotal: Channels						3,749,130
	Contingencies						375,870
	Subtotal: Channels						4,125,000
09--	TOTAL: CHANNELS AND CANALS						4,125,000
15--	DIVERSION STRUCTURES						
15--	Hope Canal (Maurepas Diversion)						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	2 10'x10' Box Culverts	Lump Sum	LS	4,858,377.00	4,858,377	485,503	5,343,880
	72" Flapgate	4	EA	20,000.00	80,000	8,000	88,000
	Pipe For Culverts	280	FT	65.00	18,200	1,820	20,020
	Site Prep For Culverts	Lump Sum	LS	20,000.00	20,000	2,000	22,000
	Riprap I-10 Bridge	25,000	TN	25.00	625,000	62,500	687,500
	Rock For Channel Construction	10,000	TN	25.00	250,000	25,000	275,000
	Spoil Bank Gapping	Lump Sum	LS	76,000.00	76,000	7,600	83,600
15--	Subtotal: Maurepas Diversion						5,927,577
	Contingencies						592,423
15--	Subtotal: Maurepas Diversion						6,520,000
15--	TOTAL: DIVERSION STRUCTURES						6,520,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				2,973,000	595,000	3,568,000
	PED				1,818,000	364,000	2,182,000
	E&D				991,000	198,000	1,189,000
	Monitoring				594,000	119,000	713,000
30--	Subtotal: Engineering And Design						6,376,000
	Contingencies						1,276,000
30--	TOTAL: ENGINEERING AND DESIGN						7,652,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				2,973,000	595,000	3,568,000
31--	Subtotal: Construction Management						2,973,000
	Contingencies						595,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						3,568,000
	TOTAL PROJECT COST						70,513,000

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater introduction. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the pipes and minor construction events to maintain the performance of outfall management measures. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $120,000.

Table 3 provides a summary of the first costs for the reintroduction of Mississippi River water into Hope Canal and the Maurepas Swamp project.

Table 3. Summary of Costs for the LCA Plan Small Diversion at Hope Canal (June 2004 Price Level)		
Lands and Damages	$	26,383,000
Elements:		
Relocations	$	22,384,000
Channels and Canals	$	4,125,000
Diversion Structures	$	6,520,000
Monitoring	$	594,000
First Cost	$	60,006,000
Feasibility-Level Decision Document	$	3,568,000
Preconstruction Engineering, and Design (PED)	$	2,182,000
Engineering, and Design (E&D)	$	1,189,000
Supervision and Administration (S&A)	$	3,568,000
Total Cost	$	70,513,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 4**.

Table 4. Small Diversion at Hope Canal FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 1,784,000	$ 1,784,000	$ 3,568,000
PED (65%Fed-35%NFS)	$ 2,182,000	$ -	$ 2,182,000
LERR&D (100% NFS)*	$ -	$ 48,767,000	$ 48,767,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 10,645,000	$ (25,336,250)	$ 10,645,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 1,189,000	$ -	$ 1,189,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 3,568,000	$ -	$ 3,568,000
Monitoring (65%Fed-35%NFS)	$ 594,000	$ -	$ 594,000
Total Construction	**$ 18,178,000**	**$ 23,430,750**	**$ 66,945,000**
TOTAL COST	**$ 19,962,000**	**$ 25,214,750**	**$ 70,513,000**
Cash Contribution	*$ 47,082,250*	*$ (25,336,250)*	

*For the conditionally authorized feature, Small Diversion at Hope Canal, LERR&D exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Small Diversion Hope Canal features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two and a half years (January 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in January 2007 and are forecast for completion in October 2008. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as October 2008, with construction completion estimated for spring in the year 2013.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

The NEPA process has been initiated as part of the ongoing CWPPRA effort on the Hope Canal project. The work conducted thus far as part of the NEPA process would be applicable to the EIS that would be prepared as part of the LCA contingent authorization process. Similarly, the engineering and environmental information developed thus far under CWPPRA would expedite development of both the EIS and the feasibility study.

The environmental impacts of the near-term features recommended in the LCA authorization are covered in the Programmatic Environmental Impact Statement (PEIS) for the study. In addition, each specific project recommended will proceed through feasibility study for approval requiring project specific review under NEPA through a Supplemental Environmental Impact Statement (SEIS) or Environmental Assessment (EA). These environmental compliance actions will be completed in decision documents to be reviewed and approved by the Secretary of the Army.

During the plan formulation process, the LCA PDT assessed the impacts of various restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plan carried over for detailed analysis. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

All major environmental restoration projects come with uncertainties and risks. Thorough study and review prior to project implementation is critical for minimizing such risks and uncertainties. Effective monitoring and adaptive management (included as part of the LCA Study) is key for managing unforeseen consequences and maximizing project effectiveness.

As outlined above, the Hope Canal project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This review process has helped identify and address a number of potential questions/concerns, such as whether river reintroduction could cause flooding, and what would occur if there were a hazardous substance spilled in the river near the reintroduction structure. While more information and evaluation will be needed to fully answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, the increased channel capacity in Hope Canal should provide greater ability to remove storm water from the existing drainage system, and the operation plan for the reintroduction project would be developed to accommodate such a use.

Recommendations/Summary

The Hope Canal project offers an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Accordingly, it should be included in the contingent authorization category for the LCA Study.

Sources

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www.epa.gov/region6/6wq/ecopro/em/cwppra/maurepas/a_maur_report2.pdf

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The accelerated loss of Louisiana's coastal wetlands has been ongoing since at least the early 1900s with commensurate deleterious effects on the ecosystem and possible future negative impacts to the economy of the region and the Nation (USACE 2004 – Main Report). Contributing to these deleterious effects is the collapse of the Louisiana barrier islands and gulf coast shorelines. This Louisiana coastal area restoration feature is to restore or rebuild the natural ecological function of the two coastal barrier shorelines, known as the Caminada Headland and Shell Island Reaches.

The Louisiana barrier islands and shorelines are almost entirely uninhabited but are an essential ecosystem to the Louisiana coastal area since they include wetland habitats, essential fish habitat, and have high fish and wildlife value. The Louisiana barrier islands also protect interior coastal wetlands, which also have high fish and wildlife value within the Louisiana coastal area.

The average rate of long-term (greater than 100 years) shoreline change along the Louisiana coast is a retreat of 19.9 feet per year. The average short-term (less than 30 years) rate of shoreline change is a retreat of 30.9 feet per year (USACE 2004 – Appendix D.3). Of the 505 miles of Louisiana gulf shoreline, 484 miles (96 percent) are eroding. The Barataria Basin Barrier Shoreline Restoration Project is one of three barrier island projects in the LCA Plan of the LCA. All three of these barrier island projects are important; however, the Barataria Barrier Shoreline Restoration Project is considered critical due to the greatly degraded state of this shoreline and its key role in protecting and preserving larger inland wetland areas and bays. If this fragile area were not addressed quickly, restoration would be far more difficult and costly.

The Barataria Basin Barrier Shoreline Restoration feature was selected for contingent authorization due to its criticalness to the coast and because it is capable of being accelerated for construction. This project addresses the 15.5 miles of Louisiana coast deemed to be in critical need of restoration due to the condition of the barrier headland or gulf shoreline, and due to significant broader impacts of these coastal reaches to the Louisiana coastal area, while also being achievable on an accelerated schedule. An implementation schedule alternative is included in the Main Report and specifically for this feature later in this document.

As Louisiana's barrier islands disappear and shorelines retreat, once protected inland bays experience substantially higher waves and storm surges. These water conditions resemble those of the open Gulf of Mexico and they threaten the entire inland estuarine ecosystem. In addition the barrier island and gulf shorelines provide habitats for migratory birds, wildlife, finfish, shellfish, and other aquatic organisms including threatened or endangered species (USACE 2004 – FPEIS). Restoration of the coast is thus an essential step for the long-term health of south Louisiana (USACE 2004 - Appendix D.3). The Barataria Basin Barrier Shoreline Restoration (Caminada Headland and Shell Island Reaches) project is deemed the most critical because it maintains the integrity of the gulf shoreline and protects the interior coast from further deterioration.

Aside from supporting coastal habitats, the coastal barrier chains in Louisiana are the first line of defense for protecting wetlands, inland bays, and mainland regions from the direct effects of wind, waves, and storms. The barrier systems serve multiple defensive purposes to:

- reduce coastal flooding during periods of storm surge;
- prevent direct ocean wave attack, which would accelerate rates of erosion and degradation of marshes and other wetlands; and
- help maintain gradients between saline and freshwater, thereby preserving estuarine systems.

The morphology and integrity of barrier islands along Louisiana's shoreline are directly related to the supply of sediment contributed to the coast and the physical processes operating in this region. The Louisiana coastal area is one of the most dynamic environments that exist in nature (see USACE, 2004 - Appendix D.2). Extensive science and engineering design technology and modeling can be used to overcome this challenge for the Barataria Basin Barrier Shoreline Restoration Project (USACE, 2004 – Appendix D.9 and D.5).

The Caminada Headland has suffered loss of wetland habitat and diminished function within the gulf shoreline. Ecologic restoration would sustain the rare coastal habitats and maintain the character and function of this critical headland. Headlands in Louisiana are ancient distributaries of the Mississippi River, which are prominent wetland areas of the coast containing ridges that give significant structural integrity to the coastal landscape. Headlands are integral landforms to both adjacent interior marshes and to the lateral gulf shoreline. In this case, Bayou Lafourche and its associated ridge are a defining landform for 80 miles through interior marshes of the coast terminating at the Caminada Headland. Louisiana Highway 1 was built on this ridge (**figure 1**). At the headland, natural processes redistribute sediment along the Gulf shoreline as far away as Grand Terre Island, 20 miles distant. It is noteworthy that Port Fourchon and the only hurricane evacuation route available to the region are on this headland and would incidentally benefit from this ecologic restoration feature **(figure 2)**. Without ecologic restoration, Caminada Headland would lose most, if not all, of its function as a headland.

Shell Island, south of the port of Empire (**figure 1**), was once a single barrier island aligned along the gulf coast but it is now fragmented into several, much smaller islands displaced from the adjacent gulf shorelines. The loss of the barrier island habitat and the opening of this shoreline to the Gulf are both dramatic losses, which pose even greater potential loss to interior habitat of marsh and bays by the intrusion of the Gulf of Mexico into the coastal estuary. Ecologic restoration would rebuild two segments of the former barrier island to reestablish continuity with the adjacent gulf shorelines, which would protect the coastal estuary. Without ecologic restoration large-scale change would occur due to the encroachment of the Gulf into the coastal wetlands.

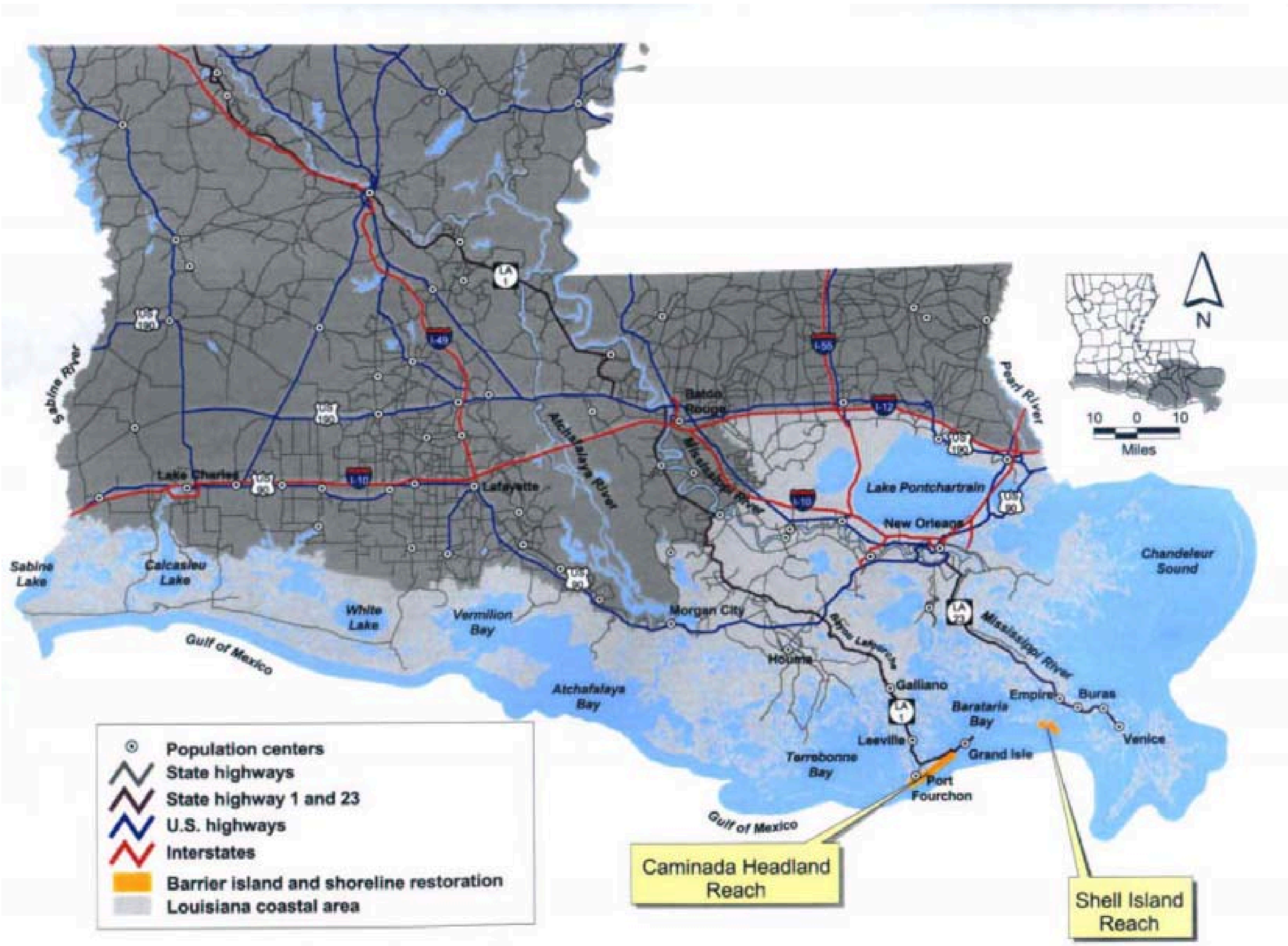


Figure 1. Map of Louisiana coast showing location of Barataria Barrier Island

Description of Area/Background

<u>Description of Area – Caminada Headland</u>

The Caminada Headland lies at the mouth of Bayou Lafourche and is defined as the area south of Highway 1 between Raccoon Pass and Caminada Pass **(figure 2)**. The beach from Belle Pass to Highway 3090 is known as Fourchon Beach. The beach at the eastern end of the island is known as Elmer's Island. This headland is unique for many reasons:

- It is the only attached erosional headland on the Louisiana coast.
- It has the highest shoreline retreat rate in the Barataria system, except for Shell Island.
- The headland has the longest uninterrupted sandy beach in the Barataria system.
- The central and eastern areas are a system of parallel abandoned beach ridges locally known as chenieres. These are covered with a rare cheniere maritime forest.

- The central portion of the headland supports the largest black mangrove "forest" in coastal Louisiana.
- Port Fourchon is located near the western portion of the headland.

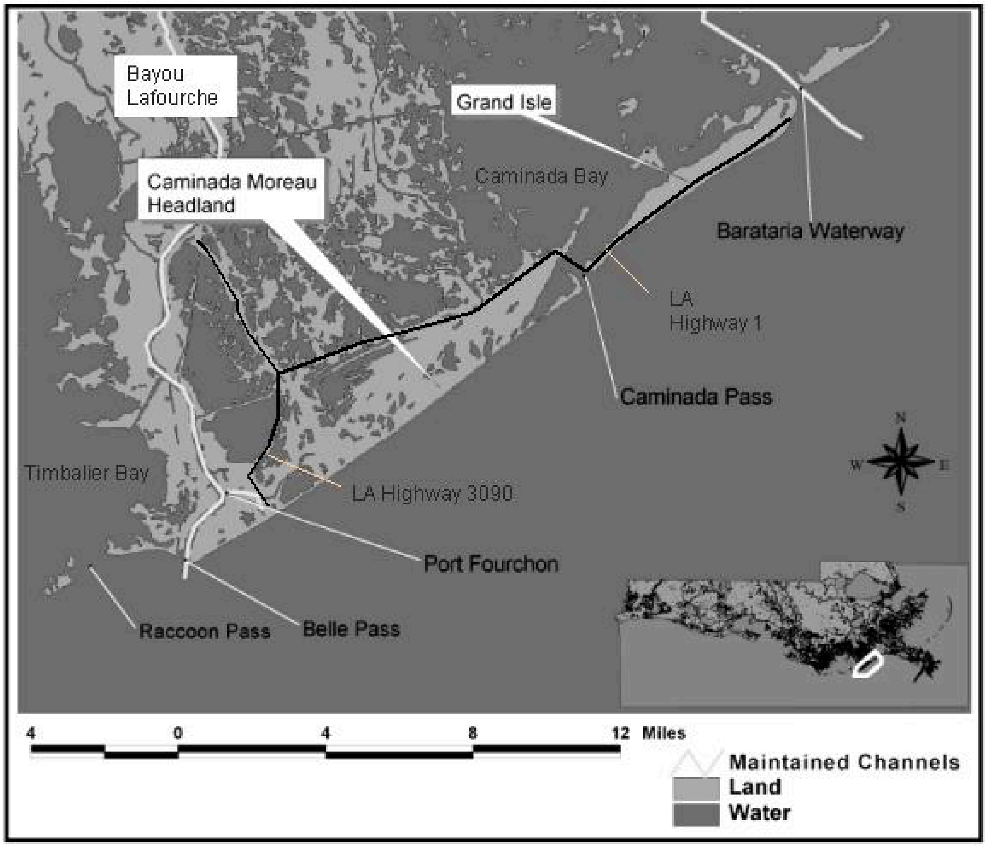


Figure 2. Map of Grand Isle and Caminada Headland with associated inlets/passes.

Physical Characteristics

The Caminada Headland formed due to the reworking and winnowing of sediments after Bayou Lafourche abandoned its delta-building phase about 800-2,500 years ago. A new delta, the Plaquemines-Belize, started forming where there was a shorter, more efficient route to the gulf. The headland is separated from East Timbalier Island to the west by Raccoon Pass and from Grand Isle to the east by Caminada Pass. Spits have formed at either end of the headland. The 13-mile long beach is quite narrow and has numerous storm overwashes. The headland has been supplying sand to East Timbalier Island and Grand Isle over the last 300 years. The area is known as a headland because it is still attached to the mainland. The next stage in this process from a delta to a headland to barrier islands to shoals is the detachment of the headland from the mainland. It then fragments into a chain of barrier islands.

Caminada Headland had a sand dune that was about 5 feet high in 1990 **(figure 3)**, a beach berm with a 1 on 35 slope and a back-barrier slope of 1 on 110. The back-barrier marshes have a slope of 1 on 300 and consist of fine sediments. Back-barrier lagoons include Bay Champagne, the area behind Caminada Spit, and several irregular shaped ponds. Numerous small bayous wind through the back barrier wetlands and there are also several man-made pipeline canals. The BP Canal is parallel to the shore, only about 1,200 feet inland from the Gulf **(figure 4)**, and runs nearly the entire length of the headland. There are also 13 locally constructed offshore breakwaters partially in front of and west of Bay Champagne.

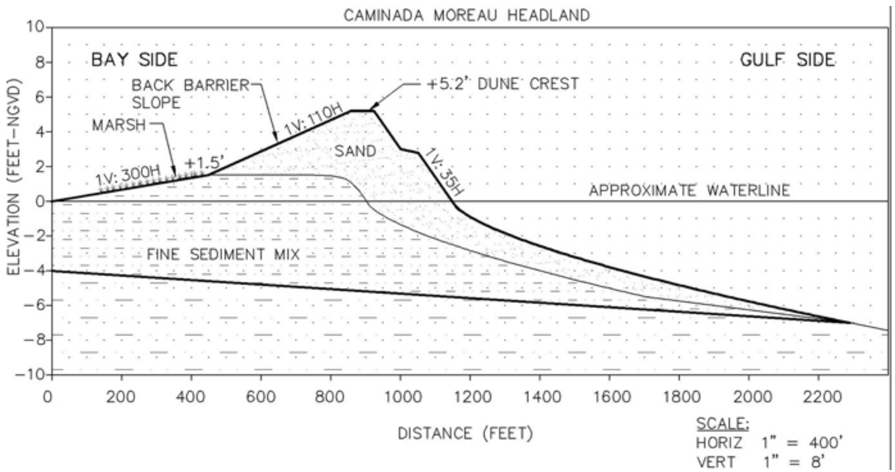


Figure 3. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Caminada Headland. Measurements originated from the cross-sections presented by Ritchie et al. (1990). The figure is vertically exaggerated 50 times for display purposes.

Bayou Lafourche, a navigable waterway with a depth of 24 feet and bottom width of 300 feet, cuts through the western portion of the headland. Rock jetties at its mouth, known as Belle Pass where the waterway is 27 feet deep, reduce the amount of maintenance dredging in the bar channel. The jetties also interrupt longshore transport to the west. Thus the eastern jetty is accreting sand and there is an erosional shadow next to the western jetty. Raccoon Spit lies immediately west of Belle Pass and historically has had some of the highest erosion rates in the state, 82 feet per year from 1887-2002, partially due to the shadow effect. However, between 1988 and 2002 the rate slowed to 21 feet per year. This was because the USACE beneficially used the material dredged from Belle Pass and its bar and placed it near Raccoon Spit to help compensate for the erosional shadow.

Figure 4. The Caminada Headland Reach illustrating a small sand beach, interior lagoons and BP Canal.

Shoreline retreat is very severe on the Caminada Headland. As can be seen in 2001 aerial photography, there were numerous washovers, especially in front of Bay Champagne in the erosional shadow of the breakwaters **(figure 5)**. There are numerous overwash areas east of what remains of Bayou Moreau near Bayou Thunder von Tronc **(figure 4)**. Most of the erosion and sand transport takes place during frontal passages and tropical storms or hurricanes. During these storms, sand is moved offshore and stored on the shoreface. Between storm events, some of the sand may be transported onshore in the form of nearshore bars. However, in general there has been a net export of material from the headland. Relative subsidence rates have been measured and the rate on the headland is approximately 3 feet per century, one of the highest in the Barataria barrier system.

Longshore transport along the Caminada Headland Reach is predominantly to the east. There is a nodal point approximately two miles east of the Belle Pass entrance. This area has had the highest retreat rates and has been the focus of numerous attempts at limiting the retreat because of valuable infrastructure behind the shore. These attempts essentially hardened the shoreline. The first was the use of soil-cement filled bags (geotubes) on the shoreline. These were locally referred to as "boudin bags." They were placed along 5,000 feet of shoreline in 1985-1986 after Hurricane Juan severely eroded the shoreline and opened Pass Fourchon to the Gulf. About 1,800 feet were protected with armor matting to prevent undermining of the bags.

This effort did not stop the sand in front of the boudin bags from being eroded. Hurricane Andrew destroyed the unprotected bags and caused damage to the 1,800 feet of protected bags, moving many back into the marsh.

The next attempt at controlling erosion was by private oil companies who built an offshore breakwater by sinking 13 old barges in 6 to 8 feet of water and filling them with stones **(figure 5)**. Beach erosion has stopped locally and sand has accreted in the lee of the four western barges. The remaining nine appear to have had no positive effect on the beach. However, there is an erosional shadow to the east of the barges where the beach has thinned and several overwash fans can be seen, including some on the beach in front of Bay Champagne. There were multiple breaches in the overwash shadow during the 2002-2003-hurricane season, In addition, the offshore side of the barges has suffered toe scour up to 2 to 4 feet and the barges are in danger of settling. If the scour continues in front of the barges, as it probably will, these barge breakwaters may fail, perhaps in the next storm. This could present a navigation hazard for small boats and the barges would be less effective at retarding erosion.

Figure 5. The coast at the northwestern segment of the Caminada Headland showing sunken barge breakwaters (center), a small downdrift erosional feature with small overwashes (top right), and the presence of industrial infrastructure and the Port Fourchon (center and top left) oil and gas production facilities.

Biological Characteristics

The 13-mile-long beach is valuable habitat for several species of shorebirds. Numerous recreationally and commercially valuable fish and shellfish such as spotted seatrout, Florida pompano and blue crabs inhabit the surf zone. Gulls, terns, pelicans and skimmers fish in the area (as well as recreational fishers). The low dunes are generally well vegetated around the base with grasses and herbs. Behind the dunes lies a unique area of parallel cheniere ridges interspersed with saline marsh, linear ponds and small lagoons. The tops of the ridges are covered with a rare cheniere maritime forest consisting of live oaks and hackberries. This community functions as an important habitat for small mammals and hawks. The trees are a vital resting area for trans-gulf migrating birds. Numerous species of birds use these cheniere forests as a stopover point to rest and refuel on their migration north and as their last stop before returning south in the fall. Both dabbling and diving ducks use waterbodies on and near the headland.

At the edges of these chenieres and north of Fourchon Beach, there are coastal mangrove thickets dominated by black mangroves. The extensive root system of this shrub helps stabilize the pond shoreline, the cover and food they provide creates an excellent nursery area for fish and shellfish, and they are heavily utilized by birds as nesting, resting or foraging areas. Some of the higher portions of the headland are covered with patches of rare coastal dune shrub thicket. This area has fairly dense stands of wax myrtle, marsh elder, groundsel bush and tooth-ache tree and is heavily used by birds and mammals. The saline marshes on the headland provide nursery grounds for many recreationally and commercially important fish and shellfish and foraging for wading birds and shorebirds. The linear ponds are rich in submerged aquatic plants. The Barataria Basin is one of the most biologically productive areas in the nation.

Several threatened and endangered species utilize the headland and adjacent waters. The threatened piping plover winters on the intertidal beach, which is designated as critical wintering habitat. The endangered brown pelican forages in the Gulf and lagoons and rests on the headland. The endangered Kemp's Ridley sea turtle forages in the nearshore area or in bays behind the headland. The threatened Gulf sturgeon potentially winters in the passes near and on the headland.

In summary, the Caminada Headland is one of the most biologically diverse areas along the Louisiana coast, due to the unusual juxtaposition of archetypal cheniere ridge habitat combined with classic high-productivity salt marsh of the Mississippi Delta Plain.

Social Characteristics

The most important infrastructure is Port Fourchon, a bustling multipurpose port, home to 125 companies, just northwest of the breakwaters and about a mile inland from the gulf **(figure 5).** The port provides land-based support for about 75 percent of the deepwater oil and gas activity in the gulf. LOOP has its land-based facilities at the port. The pipelines come ashore from the offshore docking area and booster pumps send the oil further north to a salt-dome storage area east of Galliano. The port is also a hub of the growing charter fishing industry.

There is a heliport at the port with accommodation for several helicopters. Free public facilities include a dock for commercial fishermen, a public boat launch with restroom facilities and an oilfield service dock for boats not under contract.

There are oil and gas producing facilities immediately behind the beach and south of Port Fourchon. The Port Fourchon Laboratory is a state-owned facility under the auspices of the Louisiana Universities Marine Consortium. It is available to all state universities and public and private schools. There are numerous private camps north and east of Bay Champagne.

Louisiana Highway 1 is the only land access onto the Caminada Headland. It runs south along Bayou Lafourche and then turns eastward toward Grand Isle at the point where the headland joins the mainland. At that same point, Louisiana Highway 3090 extends southwestward from Highway 1 to Port Fourchon, providing the only land access to the port. Highway 1 averages 10,000 vehicles per day, 1,000 of which are cargo trucks carrying supplies for oil and gas platforms in the Gulf of Mexico. Highway 1 is the only hurricane evacuation route for the town of Grand Isle, Port Fourchon and Leeville. Due to a near continuous development of interesting and historic fishing communities along Highway 1, the highway has been designated as the Lafourche/Terrebonne Scenic Byway by the state. With a population of 1,541 (2000 census data), Grand Isle is the only developed barrier island in Louisiana and supports the oil and gas industry, a residential community, tourism, the International Grand Isle Tarpon Rodeo, and a state park.

The state-leased, 21,600-acre Wisner Wildlife Management Area lies immediately north and partially on the Caminada Headland and is protected from the Gulf of Mexico by the eastern end of the headland. This wildlife management area is under conservation management while also providing public access to hunting for rabbit and waterfowl; and to fishing for species such as speckled trout, redfish, flounder, shrimp and crab.

Fourchon Beach is a public beach on the western end of the headland with vehicle access to the beach and camping. Surf fishing and crabbing are popular. For many years Elmer's Island, at the east end of the Caminada Headland, was a heavily used private beach. Elmer's Island was open to the public for a small daily fee. After the death of the owner a few years ago, the property was put up for sale. There is significant public pressure for the state to purchase some or all of Elmer's Island for conservation and public recreational use.

Project Area Background - Shell Island Reach

Shell Island is part of the Plaquemines barrier shoreline, which is approximately 30 miles long, and extends from Sandy Point to West Grand Terre Island **(figure 6).** This section of the coast is located approximately 25 miles west of the modern Mississippi River delta and approximately 50 miles south-southeast of New Orleans.

The Plaquemines barrier shoreline has a complicated geological framework because it is associated with different phases of deltaic evolution during the Holocene. Ritchie et al. (1990) indicate that the western margins of the islands lie within the old Lafourche delta lobe, which was active until about 300 years before present (YBP). The central area lies within the St. Bernard delta complex, which was active from 1600 to 1800 YBP. The central and eastern coastal segments (which contains the Shell Island Reach) are associated with the Plaquemines delta lobe, abandoned about two centuries ago.

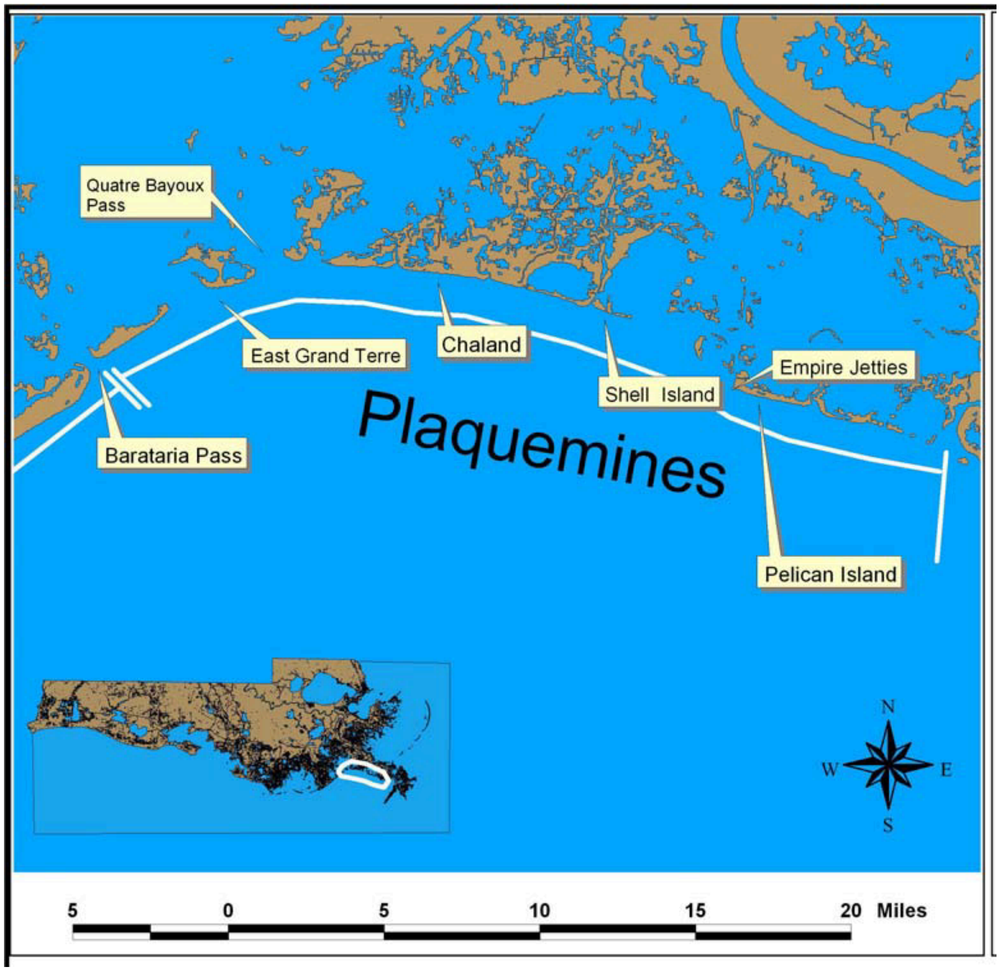


Figure 6. Map of the Plaquemines shoreline.

The Shell Island Reach stretches approximately 2.5 miles, from Fontanelle Pass to Grand Bayou Pass. Bayou Fontanelle and its Pass is the largest headland in the eastern portion of the Barataria Basin. In 1884, Shell Island formed a barrier island that appeared semi-permanently attached to Bayou Fontanelle. Longshore sediment transport appeared to be northwest toward Grand Bayou Pass. In 1884 Shell Island (also known as Launax Island) enclosed and protected Shell Island Bay. Immediately to the west of the 1884 Launax Island was a smaller barrier island only 1.2 miles in length that enclosed Bastian Bay and was attached to Grand Bayou Pass (**figure 7**). The Shell Island Reach is currently highly fragmented into small, shallow shoals and islands, which represent only a fraction of the once continuous shoreline. The remaining shoals and islands have migrated northward into Shell Island Bay.

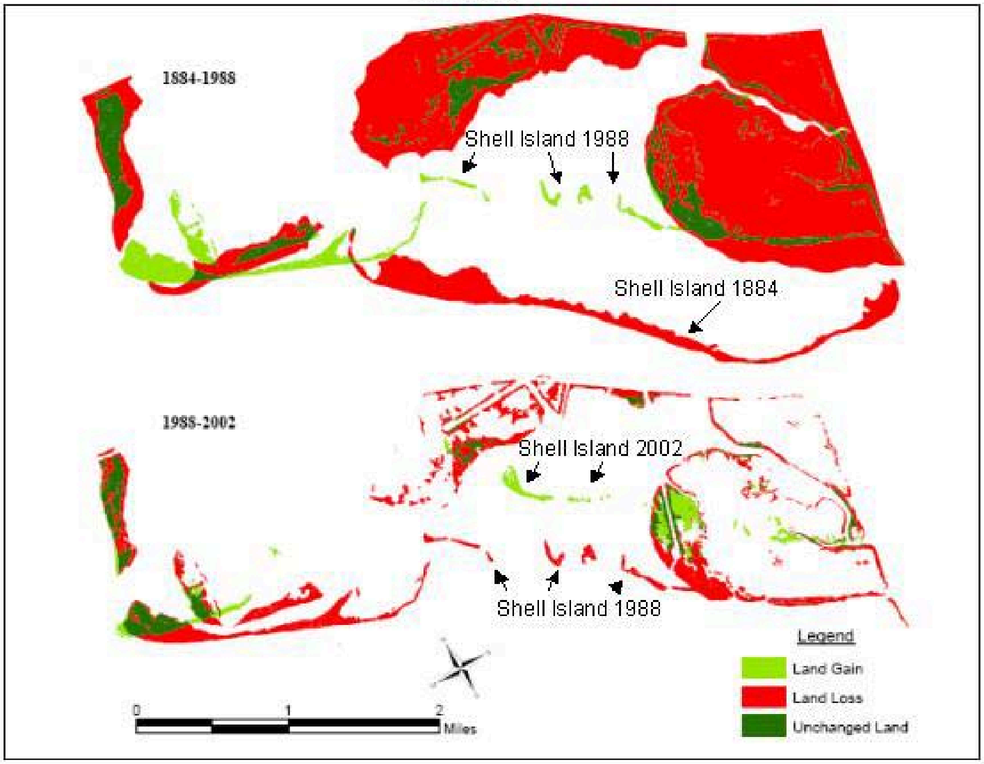


Figure 7. Map illustrating the erosional history of Shell Island 1884 to 1998 and 1988 to 2002. Note the dramatic breakup and shift of Shell Island inland.

Problems and Needs

<u>General Problems</u>

The natural processes of subsidence and erosion have combined with human-caused effects leading to significant shoreline retreat on barrier islands and headlands. Construction of levees along the Mississippi River to prevent flooding has effectively stopped the nourishment of the wetlands with nutrients and sediments. Confinement of the Mississippi has also caused the bedload to be deposited in progressively deeper waters of the Gulf of Mexico. In addition the sediment load of the river has declined by over 50% due to flood control works and bank stabilization upstream. The latter two factors have prevented the Mississippi River sediments from nourishing the downdrift barrier islands and headlands.

Specific Problems on Caminada Headland (Future Without-Project)

The Caminada Headland has some of the highest shoreline erosion rates in Louisiana. Bay Marchand, a small historic bay adjacent to Belle Pass, is now part of the Gulf of Mexico due to shoreline retreat. A similar fate is occurring to nearby Bay Champagne **(figure 8)**. Over the last 100 years erosion has averaged about 45 feet per year. From the 1970s to 1988 it also averaged about 45 feet per year. Then, from 1989 to 2002, the rate was only 9 feet per year. However, in 2003, Tropical Storm Bill eroded the beaches back as far as 60 to 80 feet. Since Louisiana is impacted by tropical storms and hurricanes once every 1.2 years, it is likely that the 40+ feet per year erosion would continue. Thus, for this report, the 45 feet per year rate from the 1970s to 1988 would be used.

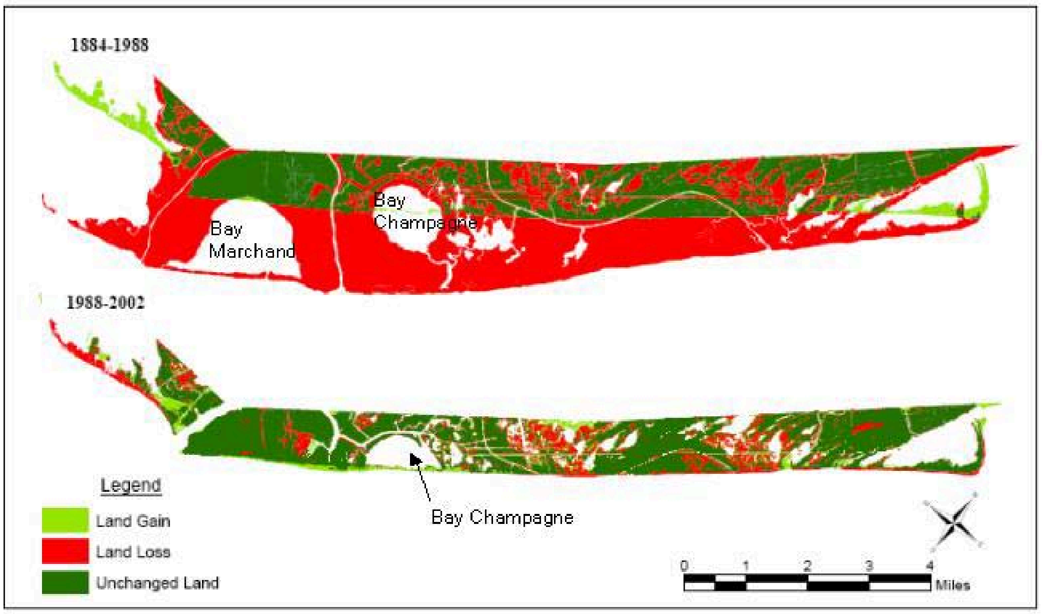


Figure 8. Map of the Caminada Headland illustrating historic land losses from 1884 to 1988 and 1988 to 2002. Note complete loss of Bay Marchand by 1988 and the continued loss of Bay Champagne by shoreline erosion.

An important factor in the retreat of the Caminada Headland is the existence of the BP canal **(figure 4)**. This canal is approximately 1,200 feet from the shoreline. If no action is taken and shoreline erosion continues, the beach would reach this canal. When this happens the sand of the shoreline would fall into the canal as happened at Shell Island. At this point, the barrier shoreline ceases to function as a barrier and recession rates would increase dramatically. Using the average shoreline recession of 45 feet per year, this could occur in about 27 years (or far sooner if a near-miss or direct hit from a hurricane occurs). When the shoreline reached the canal at Shell Island, the recession rate jumped seven-fold from 20 feet per year to 138 feet per year. It is unlikely that such a dramatic increase would occur at Caminada Headland since there is much less open water behind the BP canal than there was at Shell Island. However, in 30 years there will be much more open water than there is now. It is probable that the increase would be about half of what was seen at Shell Island. This means that the rate would jump to 132 feet per year and thus, in 50 years, the shoreline could well be 4,200 feet inland from where it is now, just assuming a linear erosion rate.

There is an erosional shadow to the east of the 13 barges where the beach has thinned and several overwash fans can be seen, some on the beach in front of Bay Champagne. There were multiple breaches in the overwash shadow during the 2002-2003 hurricane season. It is likely that within the next 5 to 10 years this erosional shadow could cause a significant breach in the beach in front of Bay Champagne. The northeastern shore of this bay is very fragile due to numerous intersecting canals. It is highly probable that the headland could fragment somewhere over a nearly two-mile area from the western shore of Bay Champagne to the remnant Bayou Moreau ridge and back to or past Highway 3090. This breach would change the western portion of the headland into Fourchon “Island”. Much of the rare mangrove and the coastal dune shrub thickets would be destroyed, increasing stress on birds, mammals and fish that rely on these areas for food, nesting and resting. It is this scenario that makes the Caminada Headland a candidate for a near-term project.

Additional evidence indicates that with no intervention, the Caminada Headland will not remain as it is now (**figure 9**). This figure is from an interagency land loss model led by USGS and prepared for the LCA Study. Map A depicts the past loss from 1956 to 2000 and Map B depicts the predicted loss between 2000 and 2050. During that time period, 3,750 acres are predicted to be lost from the headland and 14,780 acres from an area between Bayou Lafourche and Caminada Bay and about 12 miles north of the headland.

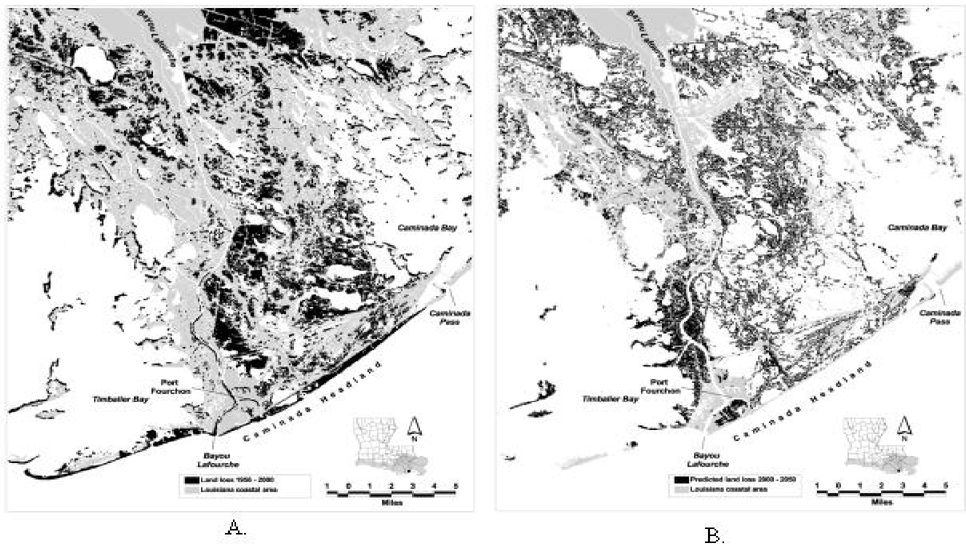


Figure 9. Caminada Headland region showing land loss (USGS 2004).

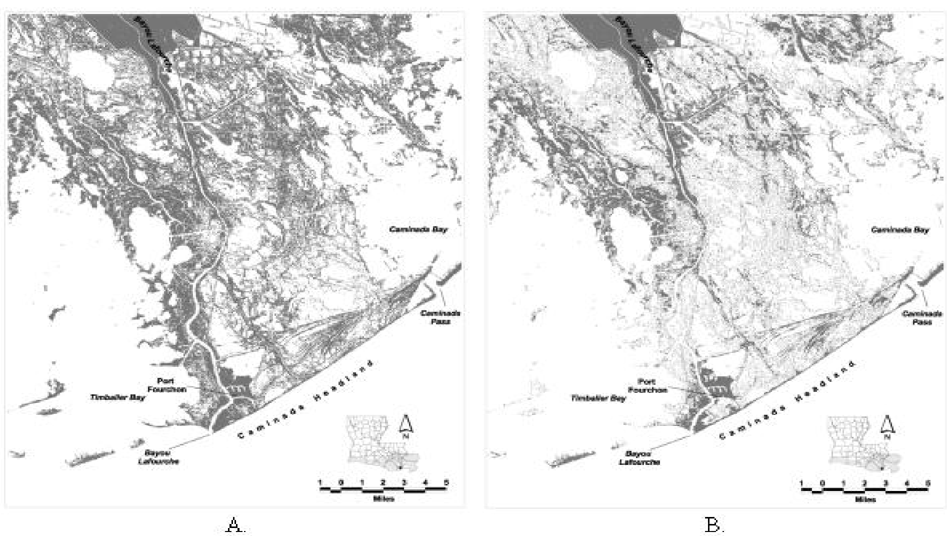


Figure 10. Caminada Headland region showing remaining land (USGS 2004).

Figure 9 illustrates the land distribution in 2000. **Figure 10** illustrates the predicted remaining lands by considering the projected losses from 2000 to 2050. It shows only a skeleton framework of wetlands remaining in 2050. The model does not project the loss of the gulf shoreline, but in actuality it would likely be far north of where it is shown in **figure 10**. The area around Port Fourchon would be further isolated from the remaining mainland, and could become a detached small barrier island.

Most of the land depicted in 2000 in **figures 9 and 10** is predicted to convert to open water due to subsidence, sea level rise, and erosion. These areas of open water would increase the tidal prism through the existing passes, especially Raccoon, and any new breaches. This would enlarge the cross sectional area of these passes. It is highly possible that sometime within the next 5 to 20 years the shoreline would breach near Bayou Thunder von Tronc. As this breach widens and continues northward, Elmer's Island would truly become an island.

The central portion of what is now a headland would probably become a barrier island well before 2050. The loss of the cheniere ridges due to subsidence, erosion, and the influence of salt spray would be devastating to neotropical migrants. The oaks would join the other "ghost" oak forests in the coastal zone. Forested areas and scrub shrub are disappearing rapidly from the Barataria Basin and these areas are vital as resting and refueling areas for both north and south migrations. This loss could further impact these migratory birds who also are being stressed by loss of wintering habitat in the south and nesting habitat in the United States.

There would still be a surf zone but the protected saline ponds and lagoons, which are now heavily used by fish and shellfish, would be much smaller (Bay Champagne and Elmer's Lagoon would be gone). In addition, there would be about 24,000 fewer acres of marsh in the Barataria Basin every 10 years. At some point the present-day prolific estuarine-dependent fishery could collapse as the marsh that fuels it disappears. The exact timing of this devastating event is unknown, but it could occur during the next 10 to 30 years. When the fishery crashes, the brown pelican, Kemp's Ridley sea turtle and the Gulf sturgeon would all be adversely affected. As the barrier islands and headlands are lost, there would be less critical wintering habitat for the piping plover and this could eventually impact the national population.

The loss of the only chenieres in the Deltaic Plain, the largest black mangrove thickets in the state, and the coastal dune shrub thickets would dramatically decrease habitat diversity in this basin. This would have the snowballing effect of reducing numbers and diversity of the birds and mammals that presently utilize these areas.

If no action is taken to prevent this retreat of the western end of the Caminada Headland and the formation of Fourchon "Island", the many critical infrastructure facilities could be seriously threatened in the near future (the next 5 to 20 years). Maintaining the headland shoreline would help avoid future damage to Port Fourchon, the largest oil and gas base in coastal Louisiana, the largest coastal fishing port, major oil and gas infrastructure, two hurricane evacuation routes, and the LOOP onshore terminal.

With the severe ecological problems delineated above, the overriding need is to preserve the Caminada headland and prevent the devastating habitat losses. It is more cost effective to protect this last erosional headland before it becomes barrier islands. Pumping sand and marsh fill onto an existing framework of dunes, remnant ridges, marshes and shallow ponds is far more efficient than pumping material into a more fragmented and deeper area. Delaying the project would allow further deterioration of this foundation, which would result in higher costs and could preclude some restoration element.

The LCA Plan has three critical needs. The first is to prevent future land loss where it is predicted to occur. Preserving this headland certainly meets this need since it is highly likely to continue the transgressive process and fragment into three islands in the next 5 to 50 years. If the headland is preserved, it is possible that 10 percent of the predicted loss in the marshes to the north could be prevented. The second LCA Critical Need is to preserve endangered, critical geomorphic structure. This headland is highly endangered since it is in the process of becoming barrier islands, a process which would destroy its biological diversity. It is critical to the stabilization of the western terminus of the Barataria Basin. As a headland, it preserves lower salinities in the lakes and bays to its north. It also provides protection to interior marsh to its north. The third LCA critical need is to protect vital local, regional and national infrastructure. This critical need is not an ecological benefit and thus cannot be used to justify this project. However, it is a definite incidental benefit of headland restoration. Since Port Fourchon supports such a large portion of the Nation's energy supply from the Gulf of Mexico, the loss of the port would have significant consequences to the parish, state, and Nation. The headland also protects Highways 1 and 3090, the hurricane evacuation routes for residents of southern Lafourche Parish, the community of Grand Isle and 6,000 offshore workers.

Problems and Needs - Shell Island Reach

The long-term erosion rate for this reach is -38.5 feet per year with a range of –8.0 to –101.5 feet per year. **Figure 7** depicts the long-term erosional history of the Shell Island area. Historically, Launax or Shell Island migrated onshore and merged with the small barrier island at Grand Bayou Pass. By 1956, Bayou Fontanelle had been jettied and Launax Island or Shell Island migrated onshore and attached to the new Empire jetties. An erosional shadow extended from the western Empire Pass jetty. The erosional shadow began affecting Shell Island because western longshore transport along the Plaquemines shoreline was disrupted. The erosion rates along Shell Island accelerated from –8feet per year to –79.5 feet per year. Shell Island narrowed rapidly and Hurricane Bob, in 1979, breached Shell Island forming Coupe Bob. The shoreline erosion rates accelerated further to –101.5 feet per year, exposing Shell Island Bay to marine processes. This pattern of barrier island degradation continued with the enlargement of Coupe Bob and by 2003 Bastion Bay was also exposed to the forces of the open Gulf.

The Shell Island Reach is important in terms of its location in the Plaquemines shoreline. The Bayou Fontanelle Headland/Shell Island system establishes the geologic framework for the orientation of the downdrift barrier shorelines of Bay Joe Wise, Chaland Island, and Cheniere Ronquille. For the management of the Plaquemines barrier shoreline it is important to understand that the longshore sediment transport is towards the northwest along this shoreline. In its present state, the Shell Island Reach represents a gap in the already minimal barrier system. This gap prevents the natural movement of sediment alongshore, resulting in a reduction of sediment to the 10 miles of barrier shoreline to the northwest. Without this downdrift nourishment, the sustainability of the barrier island system is reduced.

The restoration and maintenance of the Shell Island Reach is critically important now. Restoration of Shell Island would reestablish a linkage between island segments of the Plaquemines horeline. Historic longshore sediment transport patterns would be restored and downdrift barrier islands would benefit. The Shell Island Reach also separates the open Gulf from the back-barrier estuarine environments, helping to maintain the salinity gradients important to estuarine species. Loss of the Shell Island Reach has contributed to changes in the hydrologic patterns, allowing more saline waters to enter the estuary. In habitats with restricted variation in conditions, such as those with extreme salinity, species diversity is reduced. Since the source of salinity in coastal Louisiana is the Gulf of Mexico, salinity levels exist along a gradient, which declines as the saltwater moves inland. A zonation of plant species that differ in salinity tolerance exists along that gradient, with the species diversity of those zones increasing from salt to fresh environments (Chabreck 1972b). Numerous studies have shown that elevated salinity can negatively affect all wetland species (Chabreck and Linscombe 1982; McKee and Mendelssohn 1989). These changes in salinity gradient have reduced the productivity of this ecosystem and negatively impacted the wildlife species that depend on this habitat.

Shell Island Bay and Bastion Bay are some of the most productive oyster habitat and have traditionally supported important fisheries. The oyster fishery was lost when Shell Island was washed away by a combination of the disruptive updrift Empire Pass jetties, Hurricane Bob in 1979, and subsequent storms in the following years. Restoration of the Shell Island Reach would help bring back these important fisheries.

The Shell Island Reach is a critical storm and hurricane protection buffer that acts to reduce wave energy and tidal surge in the area north of the reach. It reduces the loss rate of the interior wetlands. The tropical storms and hurricanes in 2002 and 2003 demonstrated the importance of restoring the Shell Island Reach. These storms validated the concept that historic storms of the same strength were having a greater and greater impact as the barrier islands and back barrier marshes erode away.

Restoration of the Shell Island Reach would address two critical needs immediately. It would 1) prevent future land loss where it is predicted to occur and 2) restore geomorphic structure. A third critical need is to protect vital infrastructure. This critical need is not an ecological benefit and thus cannot be used to justify this project. However, it is a definite incidental benefit of Shell Island restoration.

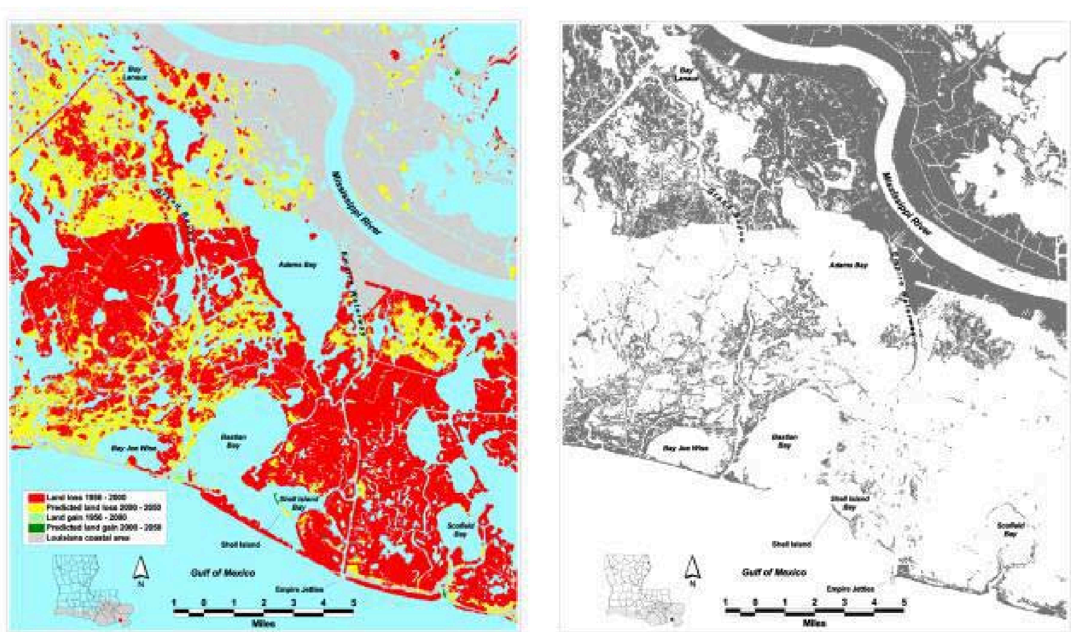
Without Project Conditions

<u>Caminada Headland</u>

Without human intervention this headland could fragment within the next 5-20 years and transgress to a detached chain of three or more barrier islands. It would be much like the condition we now find at Shell Island with equal or greater ecological consequences. Some of the last remaining stopover areas for neotropical migrants would be gone as the maritime forests on the chenieres are lost. This would increase stress on these small birds that are already highly stressed in their wintering and nesting areas. Salinities would increase in lakes and bays to the north. Some critical wintering habitat for the threatened piping plover would be lost. As the headland fragments into islands, it would provide less protection to marshes to the north.

<u>Shell Island Reach</u>

Delay in the Shell Islands Reach jeopardizes the remaining framework of the barrier shoreline and interior bays north of the Shell Islands Reach. Shell Island Bay north of Shell Islands Reach is nearly open into the adjacent Bastian Bay **(figure 11).** A single hurricane event may trigger the collapse of the interior bay system and is a compelling reason that this project should be accelerated and that contingent authorization is warranted. A direct hurricane or tropical storm impact can be expected in less than seven years. Complete opening of the bays would nearly double open water and fetch within these bays, decreasing their ecologic value. North of Bastian Bay, only a few marsh islands and small ridges separate it from the much larger Adams Bay. Coalescence of the three bays would continue and accelerate without this project. Without the project, a large sound would develop between Empire and the Gulf of Mexico. This sound would have a profound impact on the entire region. Ecologic changes would occur and storm surges would increase requiring greater levels of flood and wave erosion protection. As this coastal reach progressively collapses northward and allows intrusion of the Gulf of Mexico, restoration would become progressively more expensive and difficult to implement.



A. B.

Figure 11. Shell Island Reach Land Loss (USGS 2004)

Figure 11 illustrates extreme land loss in this area and the 1,770 acres of land that are projected to be lost in the next 50 years north of the Shell Island Reach. This area is bounded by the north shore of Adams Bay on the north, the Shell Island Reach on the south, Grand Bayou on the west, and the Empire Waterway on the east. This area is approximately 22,000 acres in size. The window of time available is uncertain since the next direct strike of a hurricane cannot be predicted, but if barrier island restoration bypasses the window, the post-storm restoration would be for an entire bays system rather than a few miles of barrier island. That is the risk of missing this window and the risk of not having contingent authorization.

Synergy with Other Restoration Projects - Caminada Headland

Restoration of the Caminada Headland would function synergistically with the Modification of the Davis Pond diversion project for marsh creation and with the Small Bayou Lafourche Reintroduction. The headland would provide some protection to the marshes that these projects preserved. The restoration of the Caminada Headland would also function synergistically with the proposed Third Delta Study, which would build a delta over time in Little Lake to the north. If the headland were preserved, it would provide protection to the developing delta from tides and saline waters. In turn, the nutrient-rich river water would nourish the marshes on the headland. If the headland is not preserved and becomes breached as described above, it could not serve these synergistic functions.

The Caminada Headland would also provide some protection to any deltas that would develop if the management of the Birdsfoot Delta would create marsh to the west.

Synergy with Other Restoration Projects - Shell Island Reach

The restoration of the Shell Island Reach is a necessary element for any future barrier shoreline restoration strategies aimed at restoring the ecosystem functions of coastal barriers. It would function synergistically with the Medium Diversion at Myrtle Grove with Dedicated Dredging. The restoration of the shoreline gap at Shell Island would help preserve the marsh created and preserved by the Myrtle Grove project. The Shell Island Reach would also provide some protection to deltas that develop if management of the Birdsfoot Delta leads to creation of marsh to the west.

Alternatives Investigation

Caminada Headland

Three alternatives were considered for this headland. Alternative 1 was construction of a dune only, approximately 1,000 feet wide. Alternative 2 consisted of construction of a 1,000-foot wide dune and creation of 177 acres of marsh in a few areas behind the dune. Alternative 3 was building the same dune, but creating a 385-acre strip of marsh between the dune and the BP Canal so nearly the whole length was filled. In addition all the remaining 1,200 acres of marsh in this area would be nourished. **Table 1** indicates the benefits of the three alternatives for the Caminada Headland:

Table 1. Benefits of Caminada Headland Alternatives

Alternative	AAHU	Acres
1	535	2,052
2	621	2,229
3	732	2,437

Monitoring of existing barrier shoreline projects by the SST indicates that a wide marsh platform on a barrier shoreline helps significantly to preserve the shoreline. Thus alternative 3 was chosen which provides the maximum amount of marsh for the dune to roll back on. The cost per marsh acre is essentially the same for alternatives 2 and 3, so alternative 3 was chosen since it would provide greater longevity for the whole headland.

Shell Island Reach

The Louisiana Gulf shoreline and its barrier islands are continuously modified by fair weather wave and wind conditions, but hurricanes and tropical storms generate the most dramatic and less predictable modifications (See Uncertainties and Risk). Alternatives were considered to reduce the impact of storm events. Three basic alternatives were considered at the start of the 2002 Barrier Shoreline Study. The first was to modify the Empire Waterway jetties to avoid the downdrift shadow. This alternative was discarded because it would take several years to begin to restore the Shell Island area and maintenance dredging costs could increase. The second alternative was creation of about 12 miles of artificial ridges or reefs, ranged in parallel rows. This was not chosen because it provided no terrestrial habitat and would not significantly reduce wave height in the interior bays. The third and selected alternative was restoration of Shell Island. This plan was selected because it would create dune and marsh habitat for wildlife and fisheries, would reduce wave height in the interior bays that would help prevent the coalescence of these bays and protect interior marsh.

Hurricanes can be expected to impact the Louisiana coast once every 1.2 years. From 1901 to 1996, seven tropical storms and eight hurricanes directly impacted this region of the coast (Stone et al. 1997), which equates to an event once every 6.4 years. This breach of the coast is expected to be impacted by multiple events by 2050. Each storm poses the risk of breaching through existing islands whether they are in their natural state or have undergone restoration. Breaches through the islands may close by natural process so the island is able to "heal" itself. However some breaches become permanent and ultimately segment the island. This process leads to decline of the entire gulf shoreline as separation between islands grows. Segmented islands may eventually shrink and ultimately be lost as they become submarine shoals. Island breaching therefore is, in general, deleterious to the gulf shoreline and prevention of breaching is a primary design consideration for barrier island restoration.

The historical nature of island breaches west of the Mississippi River was investigated and it was determined that a primary control on the occurrence and location of historical island breaches was island width. **Figure 12** is a graph of barrier length (dimension measures parallel to the coast) and the island width (dimension measured perpendicular to the coast). Both the average width and the local width of the island at a particular breach are plotted (y-axis) against the island length (x-axis). It is apparent that when Louisiana barrier islands breach, it is consistently at locally narrow widths of the island. **Figure 12** demonstrates this relationship as seen in the distinct populations of local island widths and the average island widths. The appropriate (stable) island form implied by the history of Louisiana barrier islands is that island widths less than 4.5 percent of the island length have a much greater probability of breaching. As a design consideration island widths should exceed 4.5% of the island length to avoid breaching. After restoration, sediment may be lost and the island width would decrease. So construction in excess of 4.5 percent should, in general, extend the life of the island without breaching.

For the Shell Island east restoration feature, four alternatives were developed that utilized various widths and geotube configurations that best complemented the existing configuration of land. Alternative 1 had a dune/berm width of 1,000 feet and a triangular marsh with both the gulf and bay sides contained by large geotubes, approximately 300 feet apart. Alternative 2 differed only in that it was contained with small geotubes on the bay side. Alternative 3 was characterized by large geotubes on the Gulf and a temporary earthen fill dike on the bay side. Alternative 4 had a wider dune and berm of 1,150 feet and the Gulf side contained by two large geotubes that would be removed after construction.**Table 2** indicates the benefits of the Shell Island (east) Alternatives.

Table 2. Benefit Estimates

Alternative	AAHU	Acres
1	122	71
2	147	62
3	230	55
4	207	55

Alternative 3 was selected since it would ultimately have the greatest efficiency to contain placement material with lower cost than a second geotube and provide the most benefits. The width of this configuration, including marsh creation, is 1,100 feet to 2,000 feet with a length of 18,500 feet. The width ranges from 5.9 percent to 10.8 percent of the length and exceeds the 4.5 percent threshold. This reach would not have the full effect of the gulf since it is positioned within the embayment at Shell Island Reach. This overall configuration was selected due to the favorable dimensions of the footprint and because of its position within the embayment at Shell Island Reach.

For Shell Island (west) the restoration template was dictated by the remaining island configuration. A single alternative configuration was considered. This includes shoreline and dune restoration to 1,000-foot width. Including marsh creation the width is 1,100 to 2,400 feet with a length of 7,000 feet. This smaller reach would have a width 15.7% to 34.2 percent of its length. This alternative exceeds the 4.5 percent threshold. Since this island would have the full effect of the gulf and also has an open bay behind it, the additional width ratio is warranted.

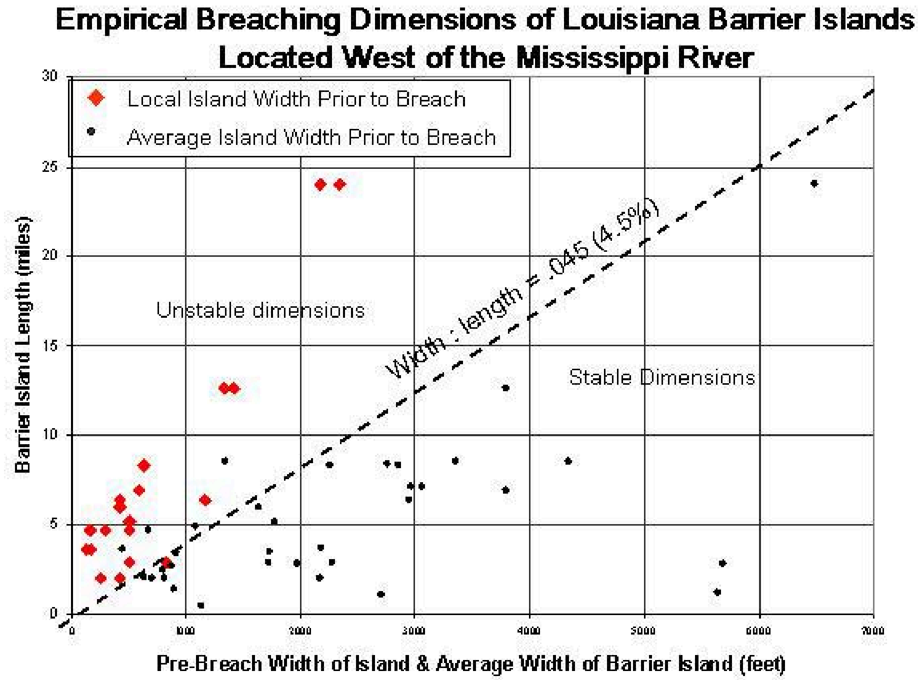


Figure 12. Graph of historical dimensions of barrier islands along the Louisiana coast west of the Mississippi River. Diamonds indicate the local island width prior to a breach. Circles indicate the average island width prior to a breach. The distinct data populations suggests barrier island widths greater than 4.5% of the length are less likely to breach. This relationship was considered in the design template for the Shell Island Restoration.

Recommended Plan

<u>Caminada Headland</u>

The selected plan at Caminada Headland would consist of dredging and placing 9 to 10 million cubic yards of sand along 13 miles of shoreline to create a dune approximately 6 feet high and a shoreward berm that is about 1,000 feet wide **(figure 13).** Thirteen existing breakwaters would be removed or covered. Approximately 2 million cubic yards of sand would be placed about every 10 years to periodically restore the dune and berm. About 6 million cubic yards of material would be placed to create a marsh area about 5 miles long and up to 1,200 feet wide. The existing eroding marsh would be nourished with a thin layer of dredged material. The BP Canal would be plugged in three places. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. After it consolidates, the marsh would be planted with smooth cordgrass, also a native variety.

Shell Island

The selected plan for Shell Island would include two components, Shell Island (west) and Shell Island (east). Shell Island (west) would involve placing 3.4 million cubic yards to create 139 acres of dune and berm and 74 acres of marsh **(figure 14)**. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. The marsh would be planted after it consolidated with smooth cordgrass, also a native variety. Shell Island (east) would involve placing 6.6 million cubic yards to create 223 acres of dune and berm and 191 acres of marsh **(figure 15)**. Material would be contained in geotubes on the gulf side and by earthen dike on the bay side. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. The marsh would be planted after it consolidated with smooth cordgrass, also a native variety.

Project Design

Project Design Considerations– Caminada Headland

Material for the dune and berm would be taken from Ship Shoal by hopper dredge. Ship Shoal is a sand body in the gulf located approximately 50 miles southwest of Belle Pass. It is about 31 miles long and 7 miles wide, lying at a depth of 9 to 30 feet. It is the remaining seaward shoal from one of the older abandoned deltas. The Maringouin delta was active 6,000 to 7,000 years ago. It is composed of well-graded quartz sand and is ideal for use in restoring the Caminada Headland since its grain size is slightly larger than the sand found on the headland.

If the pumpout is to be done in the Gulf of Mexico, the sand would be removed by hopper dredges and it would either be pumped into scows in the gulf or the hopper dredges would move to Port Fourchon for pumpout or unloading of the scows. Use of Ship Shoal sand as a borrow source would require a permit from the Department of Interior, Minerals Management Service. Permit coordination is in preliminary stages.

It is proposed to place 9 to 10 million cubic yards of good quality Ship Shoal sand along 13 miles of shore face of the beach in this reach. Ten million cubic yards is at the upper limit of the size of an achievable hopper dredge contract and any increased placement would have to be in water depths greater than 10 feet. This means less width would be attained per unit volume. In terms of headland longevity, width is an important consideration.

The rate of ecosystem restoration should be equal to the loss rate. The longshore transport is estimated to be on the order of 100,000 cubic yards per year. The loss rate due to profile adjustment to relative sea level rise is 90,000 cubic yards per year. Thus the total required restoration is 190,000 cubic yards per year. This number compares well to the dune-rebuilding requirement of 100,000 cubic yards per year computed for Grand Isle. The length of Grand Isle is roughly half that of the Caminada Headland and the required amount of sand is roughly half.

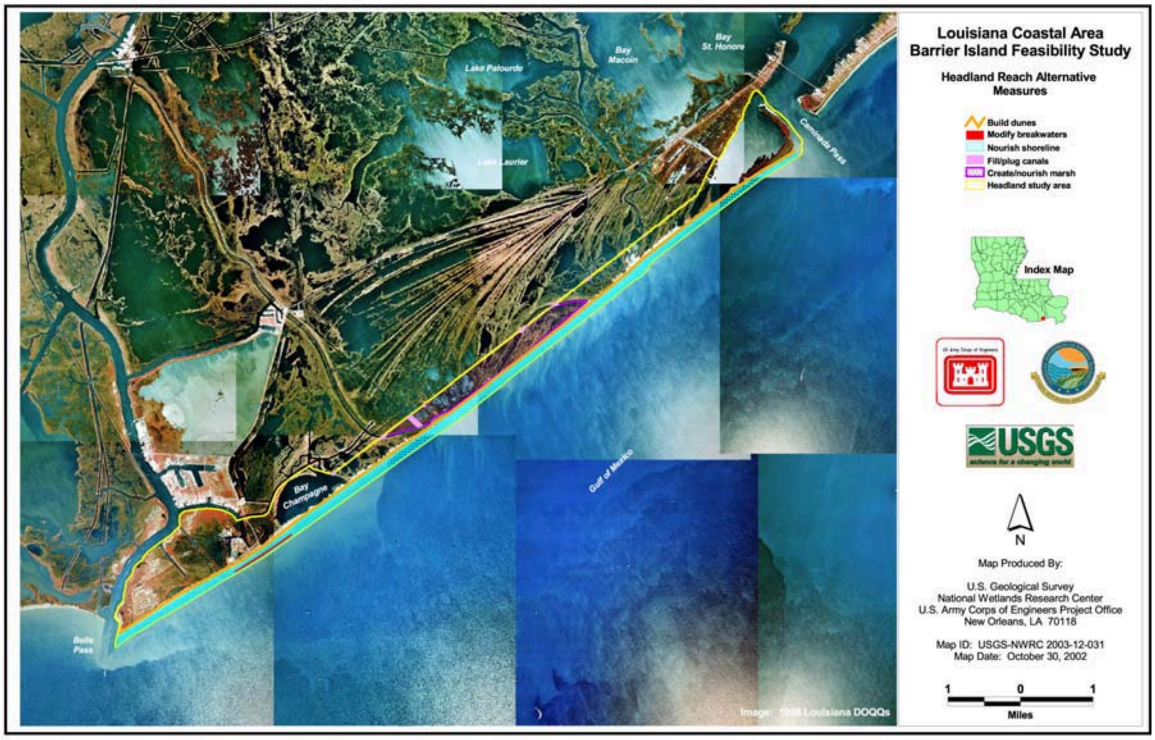


Figure 13. Caminada Headland map illustrating design template for shoreline, dune, and marsh creation.

In 2000, there were approximately 430 acres of dune and berm on the headland. The initial placement of material in a design template would raise the existing area and create another 529 acres of dune/berm habitat. But within a year the new dune would adjust to an equilibrium profile and there would be a total of 910 acres of dune/berm. If there were no ecosystem restoration, only a fraction of this would remain at the end of 50 years. This is because in the first 30 years the overwash processes would not play a significant role, but as time goes on and the barrier shoreline diminishes in both height (relative to the water level) and width, overwash would become more and more significant and thus accelerate the land loss. If the headland is nourished with periodic lifts of 2 million cubic yards every 10 years, it would erode to about 750 acres at the end of 10 years and then be re-nourished back to 910 acres.

When restoring barrier islands, a wide marsh is generally created behind the dune/berm to add stability to the island. This headland needs stabilization, but there is generally some marsh or scrub shrub immediately behind the beach/dune over much of the headland. Thus, most new marsh would be created in small back barrier lagoons that are enlarging south of the BP Canal and east of Bay Champagne. A total of five miles of marsh would be created and it would be up to 1,200 feet wide, where possible. In the areas where marsh would be created, there is now about 1,200 acres of marsh. These acres would be nourished and an additional 400 acres would be created. The BP Canal would be plugged at the three places it crosses Bayou Moreau. A short canal east of Bay Champagne would be filled to marsh level. When the marsh creation is completed, there would be a nearly continuous marsh platform between the dune and the BP Canal.

The required feasibility-level decision document for this project would consider the possibility of filling a portion of Bay Champagne. It would prevent this bay from suffering the same fate as Bay Marchand and becoming part of the gulf. Filling a portion of Elmers Lagoon would also be considered, as would a 7 to 10 foot high dune.

Small grain sized material appropriate for marsh creation would be removed from interior open water sites by cutterhead dredge and pumped to the headland. These inland borrow sites should not accelerate loss of adjacent marsh or decrease habitat value of the borrow site. Generally the fauna of a borrow site recovers within a year. During the feasibility-level document preparation, the possibility of a gulf borrow site would be considered.

In creating marsh habitat, one of the most critical factors is elevation. Created marshes change elevation over time due to three processes:

1) initial consolidation as the fill dewaters and consolidates (one to 12 months);
2) subgrade compression and settlement under the overburden of the placed material (one to five years); and
3) relative sea level rise.

Prior to starting construction, the elevation range of existing marshes would be measured. This would be the design grade, the desired range at the midpoint of design life. Prior to construction, the amount of initial consolidation would be determined by a geotechnical analysis of soil borings from the borrow sites and the fill sites. Once this is determined, grade stakes would be placed in the marsh fill area so the construction grade fill elevation can be easily determined as the job progresses. Where it is deemed necessary, low containment dikes would be built around portions of marsh creation areas. These dikes would be degraded or breached upon consolidation of the fill. Dune elevations are determined in a similar fashion, although the initial consolidation is less.

The created dune and marsh would eventually colonize naturally with native vegetation. However, to facilitate natural colonization and community diversity and to improve shoreline stability during storm events, the created areas would be planted as soon as possible. The dune would be stabilized with sand fencing prior to planting. Dune planting would occur as soon as sufficient rain has occurred to wash an appropriate amount of the salt from the fill out of the dune. Native cultivars of bitter panicum (Fourchon) and sea oats (Caminada) would be used to insure the greatest survival possible. Marshes would be allowed to consolidate for six months to one year before planting with smooth cordgrass. Work done on Grand Terre Island has indicated that this delay is essential for success.

The design described above incorporates most of the recommendations of the SRT from Appendix D of the LCA Main Report in that a wide beach berm is included and marsh is created in the existing lagoons. Recommendations for marsh elevation and for planting are also included.

Monitoring – Caminada Headland

The relative accessibility of the headland would facilitate annual surveys of the active profile. Monitoring of shoreline configuration and headland area would be done with remote-sensing techniques (aerial photography, LIDAR, satellite imagery). A regional sediment budget and a conceptual model of predominant processes on the headland should be developed utilizing the monitoring data. The success of the plantings would also be monitored. All data and knowledge gained from monitoring would be used to adaptively manage this project and to apply to subsequent barrier island projects.

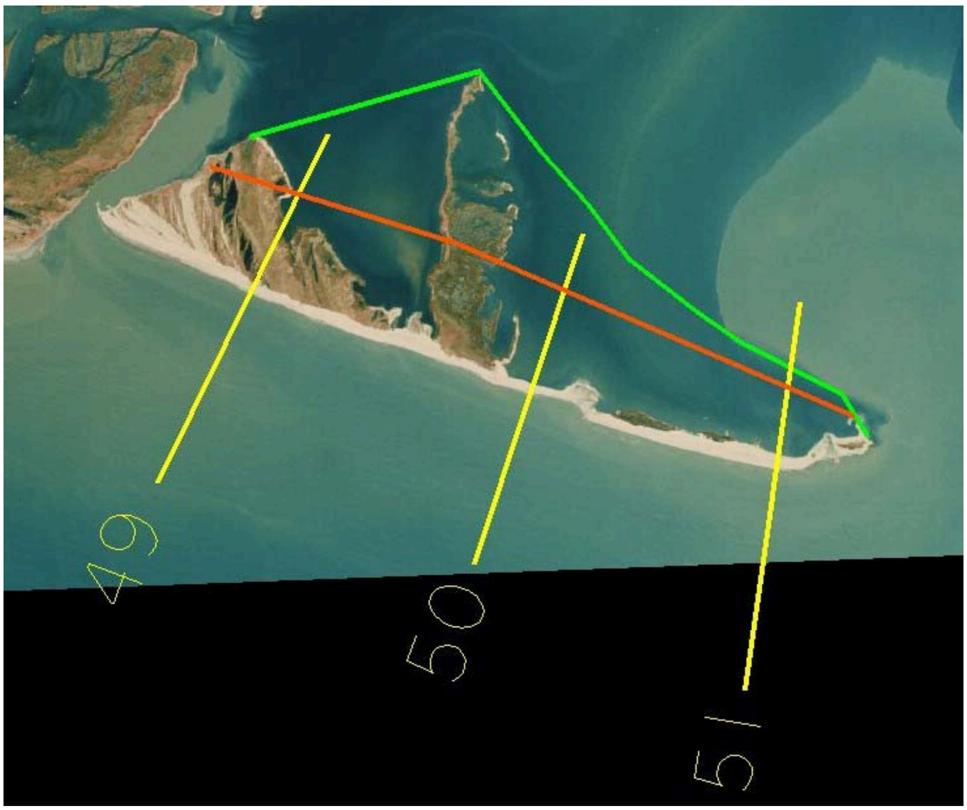


Figure 14. Map of Shell Island Reach (west) illustrating profile locations (yellow). Red line is northern limit of back of dune creation. Green line is proposed northern confinement for marsh creation.

Shell Island Reach

The extremely degraded condition of this reach requires a restoration project comprised of two sub reaches, Shell Island Reach (west) and Shell Island Reach (east) **(figures 14 and 15)**. The primary feature of both sub reaches is shoreline restoration. However, present water depth and exposure to marine conditions requires containment of placed material. Geotubes, terminal groins, and other shore protection features are required to allow the material to be placed and to protect the material after placement. Back marsh creation would be developed behind the restored beaches.

The Shell Island (west) restoration would include shoreline, dune and marsh creation **(figure 14).** The design builds upon the existing island. Sand would be pumped from a nearby offshore borrow site for the shoreline and dune restoration. The borrow site would be located sufficiently offshore to avoid wave refraction impact toe the shoreline.

The Shell Island (east) would be designed around existing remnants of marsh and marsh platform. Because the Shell Island Reach (east) affords protection to the Empire Waterway, an additional element is included to rebuild the platform west of the waterway. This would help maintain the integrity of this commercial waterway. Because of the rapid shoreline retreat in this area, the final alignment would likely change somewhat from what is shown in **figure 15**. Borings taken along the Shell Island Reach as part of the Barataria Feasibility Study indicate that the subsurface in this area is composed mainly of soft, interdistributary clays. In some areas, a thin layer of sand is found at the surface.

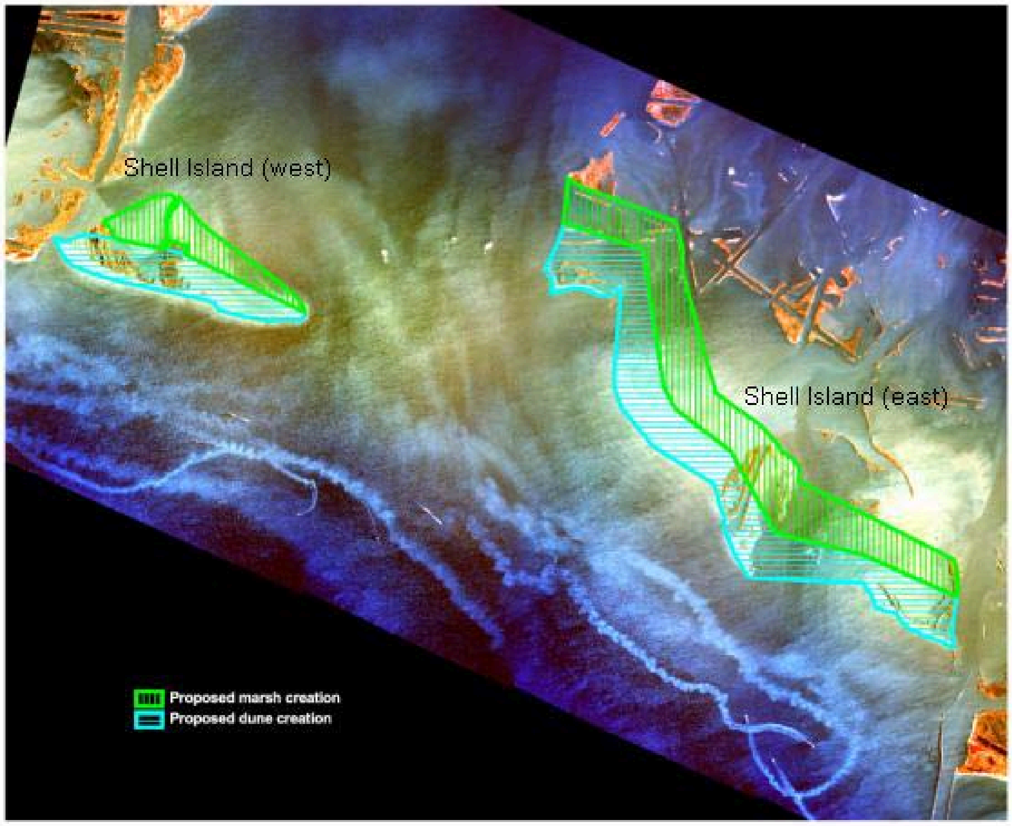


Figure 15. Map of the Shell Island Reach (east and west) illustrating the proposed location of sediment placement. The figure shows approximate locations of dune and marsh creation.

Monitoring – Shell Island

The entire active profile would be monitored for performance assessment and to determine maintenance volumetric needs. Monitoring of shoreline configuration and headland area would be done with remote-sensing techniques (aerial photography, LIDAR, satellite imagery). A regional sediment budget should be developed utilizing the monitoring data. The success of the plantings would also be monitored. All data and knowledge gained from monitoring would be used to adaptively manage this project and applied to subsequent barrier island projects.

Benefits

Caminada Headland

An interagency team with academic assistance performed both Wetland Value Assessments and Barrier Island Value Assessments during the partially completed 2000 Barrier Island Feasibility Study. The results showed that restoration of the dune/berm would produce 246 AAHUs. Marsh creation would achieve 486 AAHUs for a total of 732 AAHUs. In terms of acres, without the project there is estimated to be only about 110 acres of dune in 50 years. With the project, there is estimated to be 750 acres left, for a net gain of 640 acres of dune/berm at the end of project life. All the existing marsh on the headland is predicted to be lost in 50 years. The marsh creation effort is estimated to produce 1,780 additional acres of saline marsh at the end of 50 years. Thus, in 50 years there could be 2,440 additional acres on the headland.

The restoration done on the seaward portion of the headland would help preserve the valuable cheniere live oak forests, black mangrove thickets, and coastal dune shrub thickets that lie inland. Thus, vital habitat for small mammals, neotropical migratory birds, fish, and shellfish would be maintained. The marsh restoration/preservation would provide additional nursery habitat for fish and shellfish, feeding, nesting, and resting habitat for many songbirds, wading birds, terns, and gulls. Detritus from the marsh would help fuel the aquatic food web. Preservation of the headland would help slow the crash of Louisiana's fishery that would be caused by continued marsh loss. Numerous fish and shellfish would use the surf zone. The restored beach and berm would provide habitat for shorebirds.

Restoration of this headland would preserve the integrity of the western boundary of the Barataria Basin. It would also allow the headland to continue to nourish Grand Isle with sand transport. The headland would continue to protect the marshes to the north and keep salinity lower in the bays and lakes. The endangered brown pelican and Kemp's Ridley sea turtle and threatened Gulf sturgeon would have more fish and shellfish available. Critical intertidal habitat for the threatened piping plover would be preserved.

By adding dune/berm and marsh to the headland, all the human resources that it supports would be protected from the encroaching waters of the Gulf of Mexico. These areas include Port Fourchon, the LOOP facility, and Highways 1 and 3090 hurricane evacuation routes. This area would be able to continue to support oil and gas production in the Gulf that supplies about 20 percent of what the Nation uses.

This feature meets four of the five study objectives. Sand from Ship Shoal would be pumped onto the beach, berm and dune and would meet the hydrogeomorphic objective of increasing sediment input from sources outside the estuarine basin. Construction of the feature itself would maintain a natural landscape feature that is critical to sustainable ecosystem structure and function and thus meet another hydrogeomorphic objective. The first ecosystem objective is to sustain productive and diverse fish and wildlife habitats. The Caminada Headland is one of the most diverse habitats in the deltaic plain. The feature would also slightly help meet the second ecosystem objective of reducing nutrient delivery to the continental shelf by preserving a headland that would help trap nutrients behind it. This project is an excellent example of how ecological restoration of an exceedingly diverse and valuable ecological area can be combined with protection of Nationally important infrastructure.

In summary, this vitally important headland with its unique and diverse habitats and its commercial, recreational, and public infrastructure, that is so vital to the Nation, would be preserved. The Louisiana coast is a working wetland where people live on the natural ridges and work in the wetlands. In this area it makes sense and is wise use of public funds to preserve the wetlands, beaches, and dunes that protect vital infrastructure.

Shell Island Reach

Initial benefits analysis indicates that the most effective restoration alternative produces approximately 322 additional AAHU over the no action condition, and roughly 147 more acres at project year 50. The beach restoration would provide habitat for shorebirds and critical wintering habitat for the threatened piping plover. Marsh creation would provide additional habitat for fish and shellfish. Wading birds, songbirds, and seabirds such as the endangered brown pelican use the saline marshes for foraging, resting, and nesting. One of the most important benefits of this feature is preservation of bay habitat. As Shell Island Bay, Bastion Bay, and Bay Adams coalesce and become subject to salinity and wave conditions characteristic of the open gulf, numerous estuarine-dependent fish and shellfish would cease to utilize this area as they do now. The existence of a sound from the gulf to the back levee at Empire would change the hydrology of the southeastern Barataria Basin. Restoration of these islands would help return the Plaquemines barrier shoreline to the continuous shoreface it once was. The restored islands would help protect the fragile interior marshes between Grand Bayou and the Empire Waterway. Filling the existing shoreline gap at Shell Island would enhance longshore transport to down drift shorelines. Other benefits include protection for the Empire Waterway, an important navigation canal to both the oil industry and commercial and recreational fishing industries. The presence of the islands would also help reduce storm surges that could reach the back levee near Empire. Hurricane Danny, a weak Category 1 hurricane in 1997, caused a tremendous amount of damage to Empire and the surrounding communities because of the absence of the Shell Island Reach and the trajectory of this storm. This project incidentally helps to protect the communities of Empire, Sunrise, Buras, and Triumph.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "uninflated," costs. Expenditures include future planning, engineering, and design (PED) costs, construction costs, and monitoring costs. O&M costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The Barataria Basin Barrier Islands were divided into five reaches: Caminada, Grand Terre, Cheniere Ronquille, Scofield Pass, and Shell Island (**figure 16**). Costs were developed for two island design widths: 3,000 feet and 1,500 feet The design for the barrier islands calls for placement of sand along the shoreface and creation of back-barrier marsh behind the sand placement. The sand placement width for the two island widths is the same; the difference is in the width of the back-barrier marsh creation. The cost for the Caminada Reach is the same for both measures, as only one increment of back-marsh creation was considered for this reach. Renourishment of the beach is scheduled to occur every 10 years.

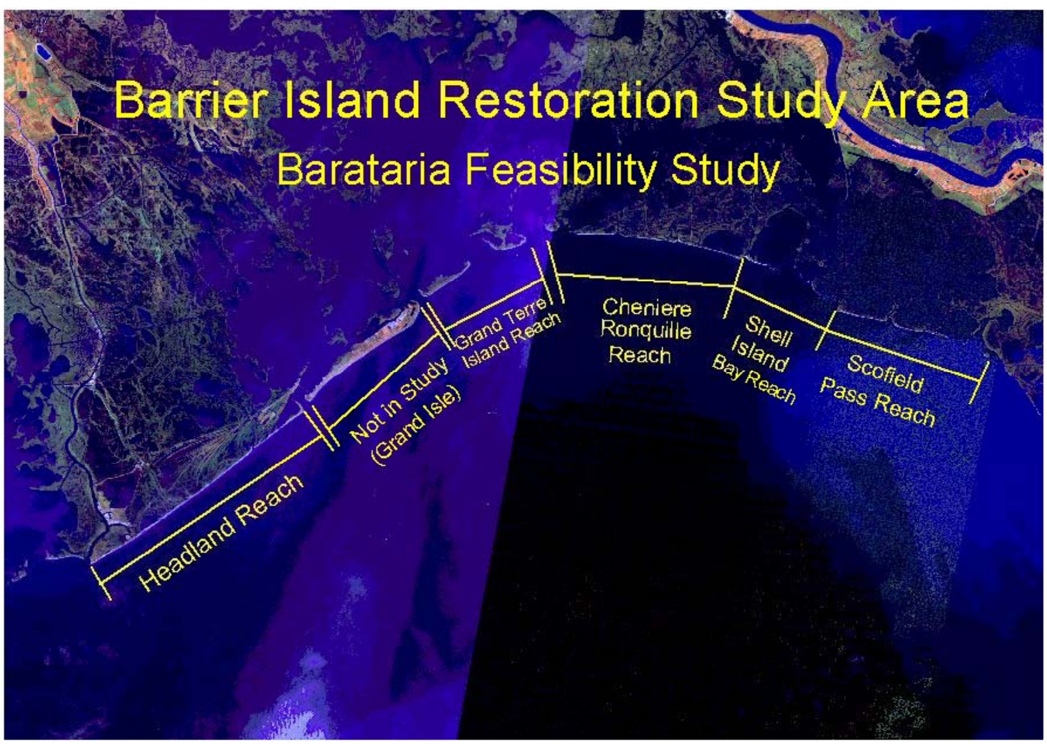


Figure 16. Map of the Barataria Feasibility Study Area

The estimated cost for designing and constructing these barrier shoreline restoration features is $247,204,000 (including monitoring). Costs for the Barataria Basin Barrier Island restoration including both the Caminada Headland and the Shell Island reaches are detailed in **table 3**.

Table 3. Costs for the Barataria Basin Barrier Island restoration feature including both Caminada Headland and Shell Island Reaches.

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
01--	Barataria Barrier Island Restoration						
	Headland Reach						
01B	Acquisitions						
01B20	By Local Sponsor (LS) (Oysters)				26,000	13,000	39,000
01B30	By Govt on Behalf of LS				75,980	37,990	113,970
01B40	Review of LS				9,750	4,880	14,630
01C	Condemnations						
01C30	By Govt on Behalf of LS				4,140	2,070	6,210
01E	Appraisal						
01E40	By Govt Contract on Behalf of LS				74,800	37,400	112,200
01E50	Review				3,200	1,600	4,800
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				5,200	2,600	7,800
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				1,560	780	2,340
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				66,550	33,280	99,830
01R1C	By Govt on Behalf of LS				7,895,450	3,947,790	11,843,240
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				175,000	87,500	262,500
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services						
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				6,000	3,000	9,000
	Subtotal: Headland Reach						8,367,280
	Contingencies						4,183,720
	Subtotal: Headland Reach						12,551,000
	Shell Island						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01B	Acquisitions						
01B20	By Local Sponsor (LS) (Oysters)				90,000	45,000	135,000
01B30	By Govt on Behalf of LS				183,488	91,738	275,226
01B40	Review of LS				33,750	16,880	50,630
01C	Condemnations						
01C30	By Govt on Behalf of LS				12,414	6,210	18,624
01E	Appraisal						
01E40	By Govt Contract on Behalf of LS				82,000	41,000	123,000
01E50	Review				8,000	4,000	12,000
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				10,400	5,200	15,600
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				1,560	780	2,340
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				788,700	394,450	1,183,150
01R1C	By Govt on Behalf of LS				220,300	110,650	330,950
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				540,000	270,000	810,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services						
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				10,000	5,000	15,000
	Subtotal: Shell Island						2,004,262
	Contingencies						1,002,738
	Subtotal: Shell Island						3,007,000
01--	TOTAL: LANDS AND DAMAGES						15,558,000
17--	BEACH REPLENISHMENT						
	<u>Subprovince 2</u>						
17--	Barataria Barrier Island Restoration						
17--	Caminada Beach Restoration						
	Mob and Demob	2	EA	500,000.00	1,000,000	300,000	1,300,000
	Beach Restoration	9,516,000	CY	10.00	95,160,000	28,540,000	123,700,000
17--	Subtotal: Caminada Beach Restoration						96,160,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Contingencies						28,840,000
17--	Subtotal: Caminada Beach Restoration						125,000,000
17--	Caminada Marsh Creation						
	Mob and Demob	LumpSum	LS	1,400,000.00	1,400,000	420,000	1,820,000
	Dredging	5,885,000	CY	1.20	7,062,000	2,118,000	9,180,000
17--	Subtotal: Caminada Marsh Creation						8,462,000
	Contingencies						2,538,000
17--	Subtotal: Caminada Marsh Creation						11,000,000
	Shell Island Beach Restoration						
	Mob and Demob	2	EA	1,900,000.00	3,800,000	1,140,000	4,940,000
	Nourish Beach	11,000,000	CY	2.80	30,800,000	9,260,000	40,060,000
17--	Subtotal: Shell Island Beach Restoration						34,600,000
	Contingencies						10,400,000
17--	Subtotal: Shell Island Beach Restoration						45,000,000
17--	TOTAL: BEACH REPLENISHMENT						181,000,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				8,500,000	1,700,000	10,200,000
	PED				5,667,000	1,133,000	6,800,000
	E&D				8,290,000	1,670,000	9,960,000
	Monitoring				1,966,000	396,000	2,362,000
30--	Subtotal: Engineering And Design						24,423,000
	Contingencies						4,899,000
30--	TOTAL: ENGINEERING AND DESIGN						29,322,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				18,100,000	3,620,000	21,720,000
31--	Subtotal: Construction Management						18,100,000
	Contingencies						3,620,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
31--	TOTAL: CONSTRUCTION MANAGEMENT						21,720,000
	TOTAL PROJECT COST						247,204,000

Monitoring of the performance of the project features would be conducted as part of the construction portion of the plan. The purpose of including monitoring in the project is to document the performance of the structures in terms of meeting the goals of the selected plan. Monitoring would assess the engineering performance of the designs to aid in decisions regarding O&M needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature would require O&M to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the rate of shoreline retreat along the reconstructed segments. This rate would vary depending upon the return frequency of coastal storms and other factors that contribute to barrier shoreline erosion. Typical O&M actions would include engineering inspections of the sites and construction events to maintain the design elevations of the restored habitats. Maintenance of the headland would occur every 10 years when about 2 million cubic yards of sand are added to the dune and berm. No renourishment is scheduled for Shell Island. These OMRR&R actions would be the responsibility of the local sponsor. The estimated annual O&M cost is $500,000.

Table 4 provides a summary of the first costs for the Caminada Headland and Shell Island Reach features project.

Table 4. Summary of Costs for the LCA Plan
(June 2004 Price Level)

Lands and Damages	$	15,558,000
Elements:		
Beach Replenishment	$	181,000,000
Monitoring	$	1,966,000
First Cost	$	198,524,000
Feasibility-Level Decision Document	$	10,200,000
Preconstruction Engineering, and Design (PED)	$	6,800,000
Engineering, and Design (E&D)	$	9,960,000
Supervision and Administration (S&A)	$	21,720,000
Total Cost	$	247,204,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 5**.

Table 5. Barataria Basin Barrier Shoreline Restoration
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 5,100,000	$ 5,100,000	$ 10,200,000
PED (65%Fed-35%NFS)	$ 4,420,000	$ 2,380,000	$ 6,800,000
LERR&D (100% NFS)	$ -	$ 15,558,000	$ 15,558,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 127,762,700	$ 53,237,300	$ 181,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,474,000	$ 3,486,000	$ 9,960,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 14,118,000	$ 7,602,000	$ 21,720,000
Monitoring (65%Fed-35%NFS)	$ 1,277,900	$ 688,100	$ 1,966,000
Total Construction	**$ 154,052,600**	**$ 82,951,400**	**$ 237,004,000**
TOTAL COST	**$ 159,152,600**	**$ 88,051,400**	**$ 247,204,000**
Cash Contribution	*$ 159,152,600*	*$ 67,393,400*	

Implementation Plan

Initial PMP and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Barataria Basin Barrier Shoreline Restoration features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and would form the basis for assigning tasks between USACE and the sponsor, LDNR, as well as, detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two years (April 2007). PED efforts to finalize the detailed design and ready the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in October 2007 and are forecasted for completion in September 2008. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as October 2008, with construction completion estimated for spring in the year 2013.

These accelerated schedules are important for the implementation of the tentatively selected plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable. A high level of coordination and funding that will also be required to achieve the goals and objectives of the plan.

National Environmental Policy Act (NEPA)

The Programmatic Environmental Impact Statement (FPEIS) prepared for the LCA Study assessed impacts of two restoration opportunities and the Tentatively Selected Plan. These impacts are discussed for all affected natural and human resources in the study area. Cumulative impacts were analyzed as well. This PEIS provides a consistent basis for initiating a supplemental document to describe these two barrier shoreline restoration projects.

Scoping meetings would be held, a Supplemental PEIS would be prepared, as well as a Section 404(b)(1) Evaluation, Coastal Zone Consistency Determination, Endangered Species Assessment, Essential Fish Habitat Evaluation, Cultural Resources Assessment, HTRW Analysis, water and sediment quality assessment, and all other documents required by law. There would be public meetings on the EIS and all comments, verbal and written would receive responses.

Uncertainties and Risk

Adaptive Management

The Louisiana coast was naturally constructed of sediment delivered by the Mississippi River of which 70 percent is clay particles (mud). Of the remaining 30 percent, only a portion is sufficiently coarse to be stable within the environment of a gulf coast shoreline. The barrier islands of Louisiana are a thin sand cap over a thick mud system that is responding to a rapid relative sea level rise of about 1 cm per year (Penland and Ramsey 1991). The sand budget for shorelines is a relatively small fraction of available sediment and therefore the challenge for Louisiana barrier island or shoreline management is to maximize sand in the beach environment and minimize sand dispersal into the surrounding mud environments. This must be accomplished in a context of a highly dynamic system in which both fair weather (fair weather includes all weather conditions other than tropical systems such as hurricanes) and storm conditions may continuously or sporadically alter the movement of sand.

Fair Weather Conditions

Fair weather conditions are the dominant conditions and can be predicted from historical wind-rose data and from wave propagation models. The effect of waves on a simple continuous shoreline can be accurately modeled. However as complexity is added to the shape of the shoreline or with additional elements, such as tidal passes or artificial structures including groins or breakers, the accuracy of prediction becomes significantly less.

This requires a restoration approach, which considers multiple possible scenarios to ameliorate the risk of undesired results. This includes:

1) Maximizing the use of sand, which is sufficiently coarse to be stable in fair weather conditions;
2) Placement of sand in increments to allow future sand placement to adjust to the beach's response to restoration and other processes;
3) Placement of sand on the updrift to allow natural dispersal of sand;
4) Monitoring fair weather conditions processes, particularly sand movement;
5) Planning for loss or gains of sand from adjacent reaches;
6) Designing beach restoration with contiguous vegetated marsh platforms landward (either natural or constructed) which would protect the bayside of the islands;
7) Minimize breaches or passes through the reach to minimize tidal movement of sand away from the beach.

Storm Conditions

Storm conditions involve another set of physical conditions, which are much higher energy but are relatively brief i.e. a few days. Louisiana is impacted by a hurricane approximately every 1.2 years. The Caminada Headland and Shell Island Reaches can be expected to be impacted once every six to seven years, which suggests multiple impacts during the life of the project. Wind and sea conditions can be generally predicted from a storm but many variables related to these storms can alter the degree or type of impact. The angle of approach of a storm to the coast and the speed of the storm are just two variables that could easily increase or decrease the impact of an individual storm. The specific location and specific type of impact from a hurricane or tropical storm is impossible to predict in advance of project construction. In addition, cost to "hurricane proof" an entire barrier Island or gulf shoreline would probably require prohibitively expensive armoring and would defeat goals of environmental restoration. Armoring of the gulf shoreline should only be done strategically and minimally.

Generally it should be expected that passage of storm events would impact the natural and restored portions of the Caminada Headland and Shell Island Reaches. The types of impact include:

1) Significant, rapid shoreline retreat
2) Breaches through barrier islands
3) Dispersal of sand both gulfward and bayward
4) Loss of dunes
5) Loss of both emergent and submersed vegetation on or adjacent to the shoreline

All of these impacts can influence the subsequent response of the beach or barrier island. This response may be either positive or negative toward the restoration goals.

Strategies to ameliorate the immediate or subsequent impact of storm events include:

1) Design of barrier islands or beaches to sufficient height and width to minimize the risk of breaching

2) Planning for emergency repair of breaches for those reaches which are not likely to close by natural shoreline processes
3) Planning for emergency sand fencing and planting to quickly restore dunes
4) Compliment the barrier island and beach restoration with interior marsh restoration to reduce the increase in tidal prism

Subject to Feasibility

The major area of uncertainty in this restoration feature is the unpredictability of shoreline processes and the response to restoration. A detailed survey of existing conditions and processes would provide a foundation for modeling of shoreline processes necessary to design these features to result in the physical and biologic response necessary to produce the final decision document for this feature. The identification of secondary socioeconomic effects, if any, for existing private and commercial development in the immediate area also should be examined.

Contingent Authorization/Demos/S&T

Contingent authority allows for acceleration of the Baratria Basin Barrier Shoreline Restoration feature and flexibility necessary to address the dynamic and continuously evolving shoreline of this project. One certainty is that the shoreline conditions would continue to change and that Shell Island would continue to roll back and fragment and Caminada Headland would become detached from the mainland and breach into barrier islands.

Placement techniques and cost of material suitably coarse for effective beach nourishment would be significant precedents for future coastal restoration of the Louisiana coast. Due to inherent uncertainty of beach restoration, any large-scale barrier island or beach restoration would likely provide new understanding of the science and technology of beach restoration. Due to a scarcity of such projects in the Louisiana coast, this project is especially meaningful for the S&T of beach restoration and management.

Recommendations/Summary

The Barataria Basin Barrier Shoreline Restoration feature addresses critical ecological needs and would sustain essential geomorphic features for the protection of Louisiana's coastal wetlands and coastal infrastructure. The project is synergistic with future restoration by maintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal restoration is dependent. The design and operation of the feature would maintain the opportunity for, and support the development of, large-scale, long-range comprehensive coastal restoration. The feature would also support the opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration measures and/or adaptive management.

The Caminada Headland component of the Barataria Basin Barrier Shoreline Restoration feature should be constructed at the earliest possible date and include ecosystem restoration of the dune and berm as well as marsh creation. The overall goal of this feature is to maintain this headland reach, which would sustain significant and unique coastal habitats, help preserve endangered and threatened species, continue to transport sand to Grand Isle, and protect Port Fourchon and the only hurricane evacuation route available to the region.

The Shell Island component of the Barataria Basin Barrier Shoreline Restoration feature should be constructed at the earliest possible date and include beach restoration using containment to rebuild a vital link in the Louisiana barrier shoreline system. The overall goal is to prevent the intrusion of the Gulf of Mexico into the interior bays and marshes, which threatens fisheries and the regional ecology. The project would also help restore natural sand transport along this reach of the coast supporting the adjacent regional shorelines and various shoreline habitats. Numerous infrastructure elements such as highways, levees, ports, and oil and gas facilities located along the rim of the inland bays would incidentally benefit from this ecologic restoration.

The coastal resources at risk for the Barataria Basin Barrier Shoreline Restoration feature and the level of investigation undertaken to date provides a high level of certainty related to the appropriateness of this restoration feature and the range of alternative configurations that should be addressed in a final decision document. This project must be undertaken with a strong adaptive management approach due to the uncertainties of coastal processes and response to restoration. Monitoring-based project management would largely offset technical uncertainties. The current status of analyses and NEPA documentation also provides a high degree of confidence that the design and documentation for this restoration feature can gain approval and be implemented on an expedited schedule.

For these reasons the Barataria Basin Barrier Shoreline Restoration feature has been recommended for contingent authorization. The execution of this restoration feature constitutes an element of the most appropriate near-term action for achieving the restoration of coastal Louisiana.

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Small Bayou Lafourche Reintroduction

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Small Bayou Lafourche Reintroduction
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

Bayou Lafourche occupies a central location in Louisiana's deltaic plain, between Terrebonne and Barataria Bays (**figure 1**). This valuable estuarine complex is also Louisiana's most endangered, due in large part to the disruption of natural deltaic processes. Once a major distributary of the Mississippi River, Bayou Lafourche was a critical conduit for freshwater, nutrients, and sediment, which helped build and nourish marshes in the Barataria-Terrebonne estuary complex. Although flows down Bayou Lafourche declined as the river switched its course 800 to 1,000 years ago, the bayou continued to provide important riverine inputs until it was dammed in 1904 to alleviate flooding problems. While a limited amount of river flow (currently around 200 cfs) was subsequently restored to the bayou, there is an opportunity to use this natural distributary to increase freshwater, nutrient, and sediment inputs to coastal areas with critical restoration needs.

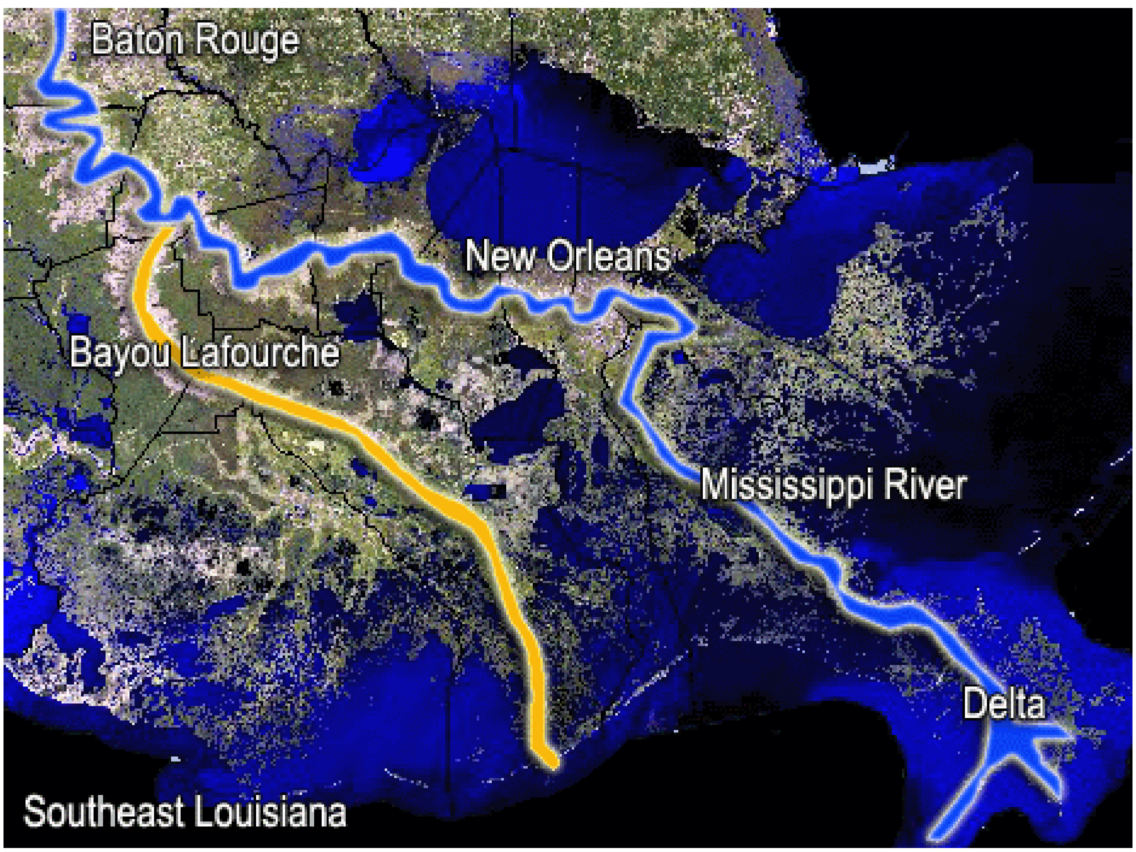

Figure 1. Project Area

The United States Environmental Protection Agency (EPA) has conducted an extensive study of Bayou Lafourche to determine if and how the channel might be enlarged to carry greater amounts of water from the Mississippi River to benefit deteriorating marshes in the lower Terrebonne and Barataria Basins. As currently proposed, the Bayou Lafourche project would increase Mississippi River flows down the bayou to approximately 1,000 cubic feet per second (cfs).

Having undergone years of interagency and public review, the Bayou Lafourche project is well suited for contingent authorization within the LCA Plan (**figure 2**). Since being selected by the CWPPRA Task Force in 1996, the Bayou Lafourche project has undergone considerable environmental and engineering review, including hydraulic modeling and environmental benefits assessment. Most recently, engineering, design, and the NEPA process have been initiated as part of the ongoing CWPPRA process. The existing information provides greater certainty with respect to costs and environmental outcomes, and will help expedite completion of both the feasibility study and EIS.

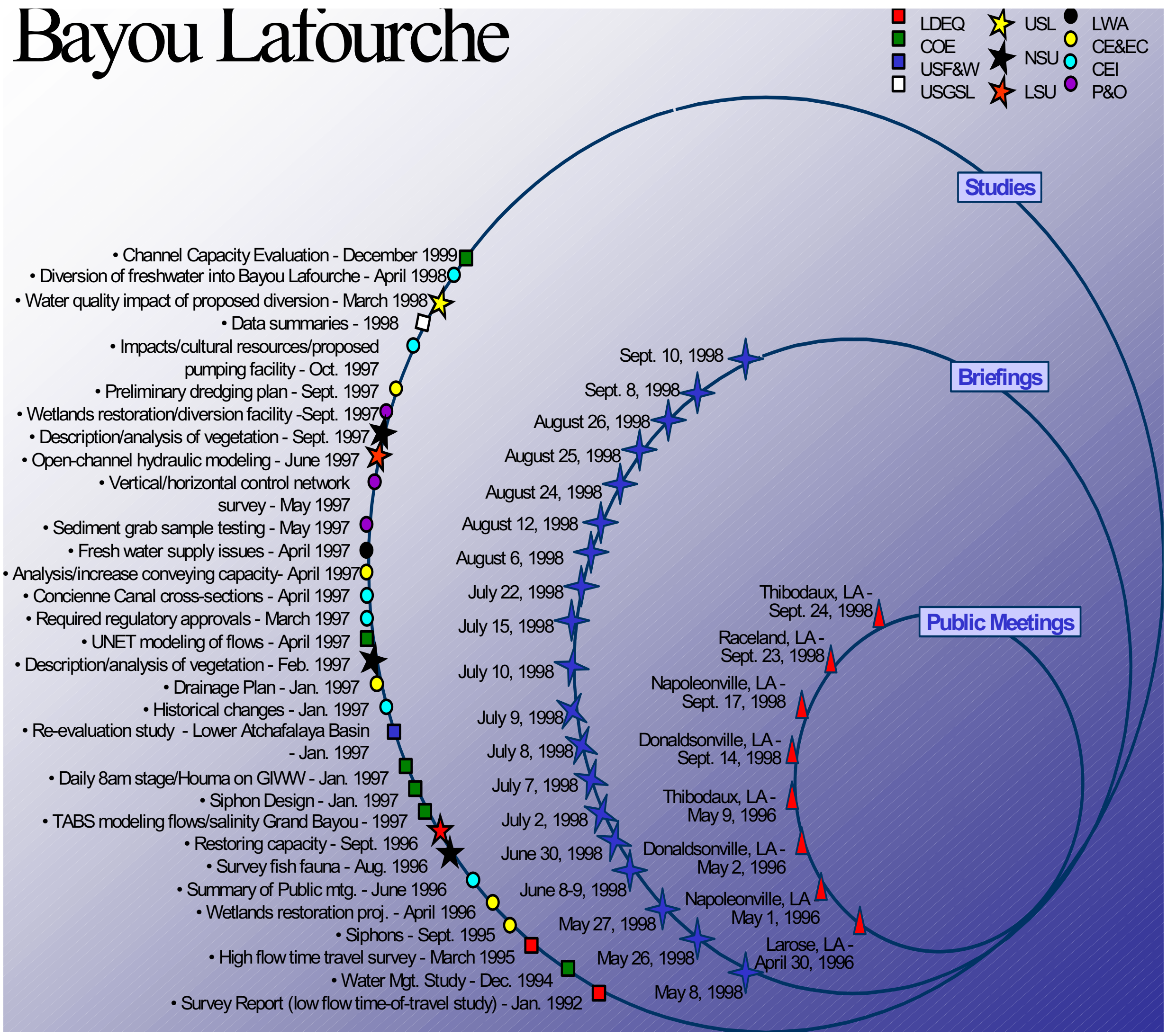

Figure 2. Project Public Involvement Description of Area

Extending 110 miles from Donaldsonville, Louisiana, to the Gulf of Mexico, Bayou Lafourche occupies a central location in Louisiana's deltaic plain, between Terrebonne and Barataria Bays, currently experiencing the highest rates of land loss in the Nation.

Following are estimates from the USGS regarding the magnitude of the past, ongoing, and future wetland losses:

- Between 1956 and 2000, the Barataria-Terrebonne estuary complex lost approximately 727.8 square miles of wetlands, or 456,800 acres, which amounts to 31 percent of the Barataria-Terrebonne land area and 61 percent of the total coastal loss in Louisiana during the same time frame.
- Between 1990 and 2000, this same area lost approximately 12.6 square miles each year, or 8,064 acres.
- USGS estimates that by 2050 this area could lose an additional 362 square miles, or 231,680 acres.

The bayou winds through the coastal parishes of Ascension, Assumption, and Lafourche. The waterway is the axis of a wide alluvial ridge created by the Mississippi River and, in its former, natural condition, the bayou fed a large number of distributary channels (**figure 3**.) The ridge slopes gently to the adjoining swamps and marshes of the Terrebonne and Barataria Basins. There is extensive commercial and residential development along the highways that parallel the bayou for most of its length. Between this development and the natural areas, the land use is primarily agriculture.

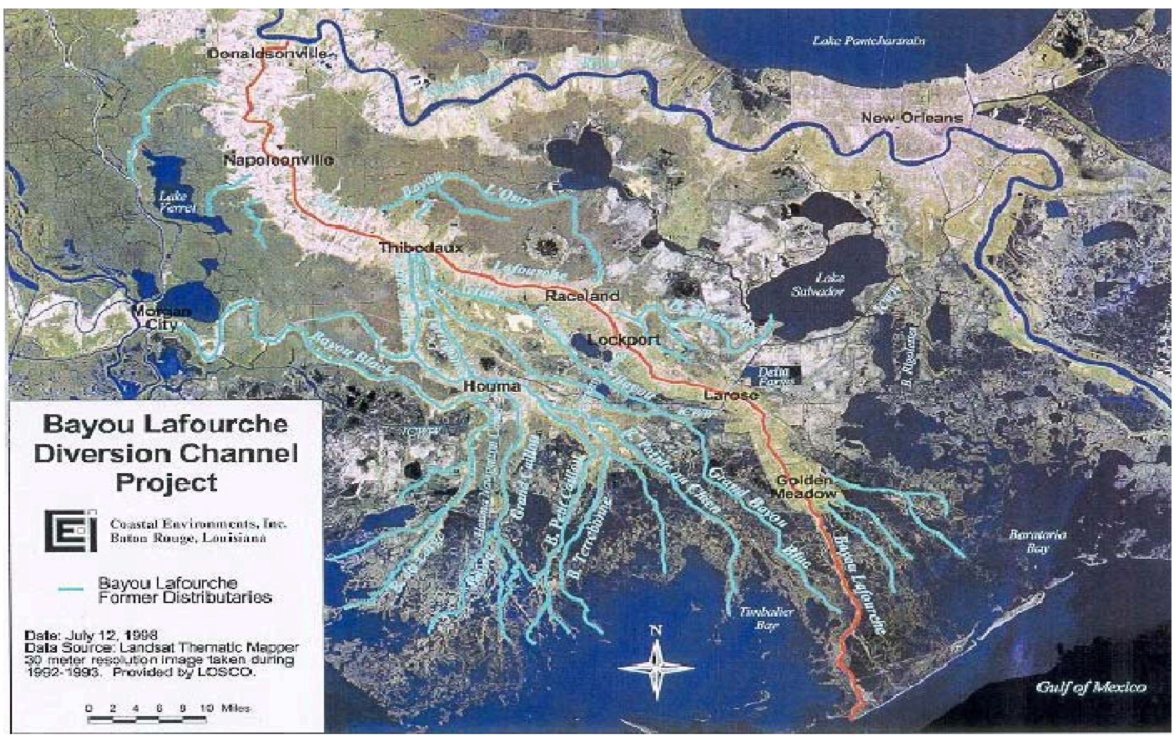

Figure 3. Proposed Diversion Channel

Historic Conditions

Approximately 2,000 years ago, the course of the Mississippi River began to occupy what is now Bayou Lafourche. This channel remained a primary distributary of the Mississippi River until about 800 to 1,000 years ago, when it was gradually replaced by the modern course of the river. While it was active, the Bayou Lafourche distributary built a large natural levee, with elevation ranging from over 20 feet NGVD near Donaldsonville, to approximately 1 foot near the mouth of the bayou.

In 1851 and 1858, discharge in Bayou Lafourche was measured at 6,000 to 11,000 cfs during high river stages. Thus, despite the shift in the river, Bayou Lafourche remained a major conduit by which freshwater, nutrients, and sediment were transported to coastal wetlands. During this time, the bayou was also extensively used for navigation.

Flows continued to decrease during the 19th century and by 1887 a bar had developed at the head of the bayou, which restricted flow and navigation. This led to annual dredging by the USACE. Additionally, the natural levee along the bayou was not sufficient to protect settled areas from flooding, and plantation owners gradually built up levees along most of the length of the bayou. Despite these levees, flood problems along Bayou Lafourche began to overshadow the usefulness of the channel for navigation. In 1902, Federal approval was given to construct a temporary dam across the head of the bayou. The dam was completed in 1904. The intent was to replace this dam with a lock, to allow for navigation. However, the dam was subsequently replaced by the Mississippi River flood control levee.

In 1906, a new problem arose: salt-water intrusion was recorded at Bush Grove Plantation just south of Lafourche Crossing. Agricultural, industrial, and domestic users recognized that fresh water would be necessary for their communities to continue to thrive. Also, damming the bayou contributed to dramatic salinity increases in the Barataria-Terrebonne estuary system. Anecdotal information gives evidence of the dramatic changes that resulted from the increased salinities. By 1910, for example, oysters were found growing in areas around Leeville, and where orange orchards and rice fields had once flourished, saltwater seeped into the land, killing the oak groves and making the soil unsuitable for farming.

Current Conditions

Responding to expanding industrial and residential demands, the Louisiana Legislature created the Bayou Lafourche Freshwater District in the 1950s. In 1955, a pump/siphon system with a capacity to reintroduce approximately 340 cfs was installed on the levee at Donaldsonville. No Federal funds were spent on that project. Because of channel constraints, this existing pump/siphon currently provides approximately 200 cfs of river water into the bayou. Approximately 80 percent of the current volume of water reintroduced to the bayou flows through the system, with approximately 20 percent being used for water supply (of which a relatively small amount is used for irrigation).

Today the bayou supplies fresh water to over 300,000 residents in four parishes: Ascension, Assumption, Lafourche and Terrebonne. In addition to residents and land-based businesses, Bayou Lafourche also provides potable water through Port Fourchon to offshore oil and gas facilities in the Gulf of Mexico. The bayou also provides aesthetic, recreation, drainage and navigation benefits to the numerous communities that have developed along its banks.

Project Background

Proposals to reconnect Bayou Lafourche as a restoration measure date back to at least 1992. At that time, coastal researchers from Louisiana State University's Center for Coastal Energy and Environmental Resources (CCEER; Currently LSU School of the Coast and the Environment) crafted a report that included reconnection of the former distributary as an innovative alternative to help address the land loss crisis in the Louisiana coastal zone. In the November 1993 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Main Report and Environmental Impact Statement (EIS) submitted to the U.S. Congress by the Task Force, reintroduction of Mississippi River water via Bayou Lafourche was listed as a major strategy for both the Terrebonne and Barataria basins.

Problems and Needs

The loss of riverine sediment, freshwater, and nutrients into the Barataria and Terrebonne basins is the most significant long-term problem facing the estuary. The damming of Bayou Lafourche, in conjunction with subsidence, sea-level rise, and other natural and anthropogenic factors has resulted in the highest rates of wetland loss in coastal Louisiana and the Nation. Other anthropogenic factors that have contributed to land loss in the area include dredging of canals, construction of navigation channels and other hydrologic modifications.

From 2000 to 2050, this estuary complex is predicted to lose approximately 231,000 acres of wetlands. This is 50 percent of the predicted loss in the entire state. In addition, approximately 465,000 acres have been lost in this complex over the past 50 years. The continued loss will further weaken an already stressed ecosystem that supports a wide range of resident and migratory animals. The highly diverse and numerous fish and shellfish populations in the complex would dramatically decline as land loss continues. In the future, there would be decreased habitat for neo-tropical migratory birds, furbearers, waterfowl, and threatened species such as the bald eagle.

Critical Need for the Project

The wetlands being lost in the Barataria-Terrebonne estuary complex are of vast ecological importance. It has been estimated that nearly one fifth of the Nation's estuarine-dependent fisheries rely on the diverse habitats of Barataria-Terrebonne estuary complex. Annual commercial fisheries landings have been estimated at more than $220 million, including oysters, shrimp, crabs, and various finfish. The wetlands and other habitats of the Barataria-Terrebonne estuary complex are also important for a wide range of resident and migratory birds. It is estimated that 353 species of birds are known to have occurred in Barataria-Terrebonne, of which 185 species are annual returning migrants. In total, approximately 735 species of birds, finfish, shellfish, reptiles, amphibians, and mammals spend all or part of their life cycle in the estuary.

The ongoing loss and conversion of these wetlands will adversely affect a range of important fish and wildlife resources. Within the estuary complex, waterfowl populations are most seriously threatened by habitat loss. Over the last 10 to 20 years, dabbling ducks, wading birds, shorebirds, seabirds, furbearers, game mammals, and alligators have experienced decreasing populations in the study area, as a result of marsh loss and a conversion to saltier marsh types. Across this area, the greatest loss of coastal wetlands has occurred in the fresh and intermediate marshes of the Terrebonne and Barataria Basins. Given the ongoing and projected wetland loss, it can be assumed that delaying project implementation would result in continued adverse impacts to the habitat and living resources discussed above.

The North American Waterfowl Management Plan (NAWMP; Canadian Wildlife Service (CWS), and U.S. Fish and Wildlife Service (USFWS) 1986), a multi-nation agreement for the management of waterfowl, proposes to restore prairie nesting areas and protect migration and wintering habitat for waterfowl and other migratory bird populations in the lower Mississippi River and Gulf Coast regions, among others. The NAWMP identifies coastal Louisiana as part of one of the most important regions in North America for the maintenance of continental waterfowl populations. The Barataria-Terrebonne estuary complex is an essential component of this region, and as such is of critical importance to waterfowl and migratory bird species. The continued loss of the wetlands in the Barataria-Terrebonne estuary complex poses an immediate and ongoing threat to such species, and hampers efforts to implement the NAWMP.

The fisheries value of the estuary complex also cannot be overemphasized. The fish community in the Barataria Basin is the most diverse of any estuary in Louisiana, with 191 species. The adjacent Terrebonne Basin is only slightly less diverse, with 153 species. The vast majority of these species depend on coastal wetlands for their existence. Mobile estuarine species utilize inundated wetlands and the marsh/water edge as habitat. These marsh areas, along with the adjacent shallow water areas are critical nursery areas for many important species. The marsh is also a critical food source in terms of detrital export. Given the rapid wetland loss and conversion, the no action plan would continue to destroy the aquatic diversity and biological productivity in this estuary complex.

The Magnuson-Stevens Fishery Conservation and Management Act of 1996 promotes the protection, conservation, and enhancement of Essential Fish Habitat (EFH). The Barataria-Terrebonne estuary complex provides a range of EFH, particularly the emergent marsh, that would be protected by the Bayou Lafourche project. As with the NAWMP, the proposed project would help meet the goals of this important Federal legislation.

Opportunities

The Bayou Lafourche reintroduction project has the potential to provide an important piece of the response to rapid ongoing wetland losses in the Barataria-Terrebonne estuary complex, but it will in no way solve the problem. Additional measures (including CWPPRA projects, other LCA near-term projects, and future large-scale efforts) will all be needed to help address historic and ongoing wetland and barrier island losses in the estuary complex. However, the Bayou Lafourche project is a critical next step in providing a more complete response, one that will provide important wetland benefits while also facilitating future restoration measures. Without such a complete response, of which Bayou Lafourche is a central component, the Barataria-Terrebonne estuary complex will continue to suffer from unacceptable levels of wetland loss.

Contingent authorization of this project would help provide much needed ecological stability and resilience, while complementary restoration projects are evaluated and implemented. Increasing the health of wetlands in the benefit areas will enhance ecosystem resiliency, which can be defined as the ability to withstand and respond to various stressors. Most notably, by increasing freshwater flows to the benefit areas, the project would help reduce the potential for wetland losses associated with periodic high salinity events. The immediate need for the project was particularly evident during the drought conditions of 2000, which have been associated with a large-scale die back of marsh vegetation in the Barataria and Terrebonne basins (due to a condition referred to as “Brown Marsh”). Although such events are stochastic in nature (i.e., difficult to predict), contingent authorization of the project would minimize the exposure to such risks for wetlands in the potential benefit areas.

While it would be possible to implement the project through the standard authorization process, doing so would unnecessarily delay implementation of a much needed restoration project. Regardless of the stochastic risks discussed in the previous paragraph, it can also be assumed, given the background loss rate in the area, that delaying implementation of the project would result in greater wetland losses. These additional wetland losses would likely result in:

- Decreased vital habitat for a diverse and highly productive coastal fishery;
- Adverse impacts to EFH;
- Decreased habitat for a wide array of resident and migratory birds and other wildlife; and
- Increased risk of marsh loss due to stochastic events, particularly drought-related losses such as “Brown Marsh.”

The cumulative effects of past losses, and the certainty that losses will continue if no restoration is conducted, establish a clear need for expediting project implementation through contingent authorization. Given the significant ecosystem services provided by the Barataria-Terrebonne wetlands and the fact that these areas are experiencing the highest loss rates in the Nation, every effort should be made to accelerate ecosystem restoration efforts through the contingent authorization process. It is clear that the ecosystem at issue is in immediate need of restoration, and that such restoration efforts should begin as soon as possible.

Alternative Investigation

The Bayou Lafourche reintroduction project has been approved by, or is consistent with, a number of major planning efforts for coastal Louisiana, including the Barataria-Terrebonne National Estuary Program Comprehensive Conservation and Management Plan, Coast 2050, the 1993 CWPPRA Comprehensive Restoration Plan, CWPPRA priority project list (PPL) 5, and all seven cost-effective, coast wide restoration frameworks developed as part of the LCA process.

Successful ecosystem restoration depends upon our ability to restore and/or mimic natural structures and processes essential to ecosystem health. In the deltaic plain of coastal Louisiana, the essential ecosystem processes that must be restored or mimicked are the natural connections between the river and the estuaries. These connections come in various forms, ranging in scale and duration from river switching, distributary flow (such as that which occurred down Bayou Lafourche), crevasses, and over-bank flow. Levees and other structures along the Mississippi River have interrupted these connections severing the essential link between the river and deltaic wetlands. Successful restoration of the deltaic plain therefore depends upon restoring the flow of Mississippi River water (with its nutrients, sediment, and freshwater) to coastal wetlands.

Consistent with the restoration rationale provided above, the analysis of alternatives for meeting river reintroduction needs is to some extent, "place-specific." In other words, there are distinct environmental and logistical advantages to using naturally existing distributaries or crevasse locations in lieu of creating artificial ones. In looking for ways to move Mississippi River water into eastern Terrebonne basin and western Barataria basin (both of which are areas of critical need), the most obvious path is via the existing distributary of Bayou Lafourche. Given the basic purpose of the Bayou Lafourche project (to restore approximately 1,000 cfs of Mississippi River flow to the study area), it would clearly not be cost effective to consider digging a new distributary channel. (Note: the cost effectiveness of creating a new distributary channel for a much larger river reintroduction project such as the so-called "Third Delta" would be reviewed as part of the proposed LCA large-scale studies.)

The Bayou Lafourche Project was initiated in 1996 and has undergone significant engineering and environmental study leading to the conceptual project, as described in the 1998 report. Leading up to the 1998 report, a number of alternatives were considered, including concepts of moving water into the area from both the east and west by "re-plumbing" the waterways in the basins. In general, it was found that the demand for freshwater in the study area far exceeded the potential supply from such alternatives. Other ways of increasing freshwater flows to Terrebonne and Barataria Bays should, therefore, be considered complements to the Bayou Lafourche project, as opposed to alternatives. Consistent with this finding, the draft LCA Study does contain another project that could deliver fresh water to the eastern Terrebonne basin (i.e., Convey Atchafalaya River Water to Northern Terrebonne Marshes). Again, rather than being alternatives to each other, these two projects are complementary components of a larger effort to address the critical needs of the Barataria-Terrebonne estuary complex.

Recommended Plan

Given the programmatic nature of the LCA Study, a definite reintroduction volume has not yet been identified. As currently conceived, the Bayou Lafourche project would increase flows in the distributary channel to approximately 1,000 cfs. Alternatives considered thus far, or currently under consideration for Bayou Lafourche, include maximizing the Mississippi River flow into Bayou Lafourche, different reintroduction structures (including siphons, pumps and gates of different capacities), and the possible use of a bypass channel around Donaldsonville. The current concept of the Bayou Lafourche project includes dredging the bayou and bank stabilization to maintain existing water levels and prevent bank failure, respectively. Following is a summary of proposed features of the Bayou Lafourche project (subject to review in the project-specific feasibility study):

- Upgrading the existing pump/siphon facility to operate at the full 340 cfs capacity and constructing a new 660 cfs pump/siphon facility.
- Improving channel capacity to 1,000 cfs by eliminating the existing fixed weir at Thibodeaux and dredging 6.7 million cubic yards of material over approximately 55 miles of the channel within its existing banks. If the dredged sediments are clean, they will be made available for local use and land application or sale. Any contaminated sediment will require special placement.
- Providing bank stability over three miles of the channel. The improved channel and bank stabilization would prevent flooding of bayou-side residents.
- Operating five monitoring stations to provide continuous information on water levels and other bayou conditions.
- Installing two adjustable weirs, one at Thibodeaux and another at Donaldsonville, to control water levels as necessary to eliminate current causes of bank instability and to facilitate passage of storm runoff.
- Constructing a sediment trap at Donaldsonville to control siltation of the main channel and insure that flows are not impeded. This trap would be cleaned on an as-needed basis.

The pumps or siphons would be operated to reintroduce Mississippi River water into Bayou Lafourche. All affected parishes would have involvement in the timing and amounts of flow. Flows would be reduced during storm events and at times of strong southerly winds. The two weirs will also control water levels. The diversion structures will be connected to the Early Warning System on the Mississippi River that lets members know of any oil or chemical spills.

UNET modeling performed by the USACE provided an estimate of the distribution and impacts of diverted water under different existing hydrologic conditions (i.e., high and low flow conditions in all major channels between Barataria estuary and Atchafalaya River, and average Gulf stage) for reintroduction inputs of 1 cfs, 500 cfs, 1,000 cfs, 1,500 cfs, and 2,000 cfs. The UNET model studies demonstrated that approximately one third of the water would go east into the Barataria Basin, one third south to the Grand Bayou marshes and lower Bayou Lafourche, and one third west toward Bayou Terrebonne and the Houma Navigation Canal.

Monitoring

The monitoring plan for this project will analyze water level and water quality data from the five monitoring stations in the bayou. Aerial imagery will be analyzed to determine if the projected marsh loss reduction is occurring. The knowledge gained from analysis of the monitoring data will be used to adaptively manage this project and to help formulate plans for other reintroductions.

Since the CWPPRA program has programmed nearly all its funds on smaller and less expensive projects, it is more appropriate to fund this ecosystem-wide project that costs more than $100 million under the LCA.

Benefits

By increasing the connection of the river to the bayou, the Bayou Lafourche project would nourish marshes, contribute to soil building through mineral sediment accretion and organic matter production, and combat saltwater intrusion during droughts or prolonged southerly winds. The associated increased vegetative health and vertical accumulation of the marsh surface would counterbalance subsidence and reduce future wetland loss in the area.

As part of the CWPPRA process, the wetland benefits of the Bayou Lafourche project, with regard to providing habitat for a variety of fish and wildlife species, were calculated using Wetland Value Assessment (WVA) methodology. The WVA was developed by the CWPPRA Environmental Work Group (EWG) to quantify changes in fish and wildlife habitat quality and quantity projected to be brought about as a result of a proposed wetland restoration project. Results are measured in Average Annual Habitat Units (AAHUs) that are representative of expected changes over time in wetland quality (habitat suitability) and quantity (acres) under future with and without project scenarios.

The Bayou Lafourche project was assessed using WVA methodology in 1998. This WVA assumed a flow of approximately 1,000 cfs delivered by siphon and/or pump. This meant that water could be diverted year-round.

Seven major wetland benefit areas were identified and subdivided according to marsh habitat type (see **figure 4**). The benefit areas encompass 85,094 acres (nearly 49,000 acres of wetlands and 36,000 acres of water). Wetland benefits were determined primarily in terms of the projected reduction in marsh loss expected to occur as a result of the project. The mechanisms through which the diversion was expected to impact marsh loss in the seven areas were: (1) the reduction of salinity stress due to increased freshwater flows, and (2) the stimulation of organic production in emergent marshes as a result of the introduction of clay sediment and nutrients. Based on the 1998 WVA, it is estimated that at the end of 50 years there would be approximately 2,500 more acres of marsh than if the project had not been built. The WVA also credited this project with increasing submerged aquatic vegetation (SAV) that improves habitat for fish and waterfowl.

Although the WVA measures many attributes of estuaries that fish and wildlife rely upon, there would be unquantifiable benefits over the 49,000 acres of wetlands and 36,000 acres of estuarine waters, especially with a project such as this that is synergistic with other projects. It is possible that the acres preserved are underestimated. There would be benefits to threatened species such as the bald eagle and higher quality EFH would be preserved. In addition, waterfowl habitat would be improved.

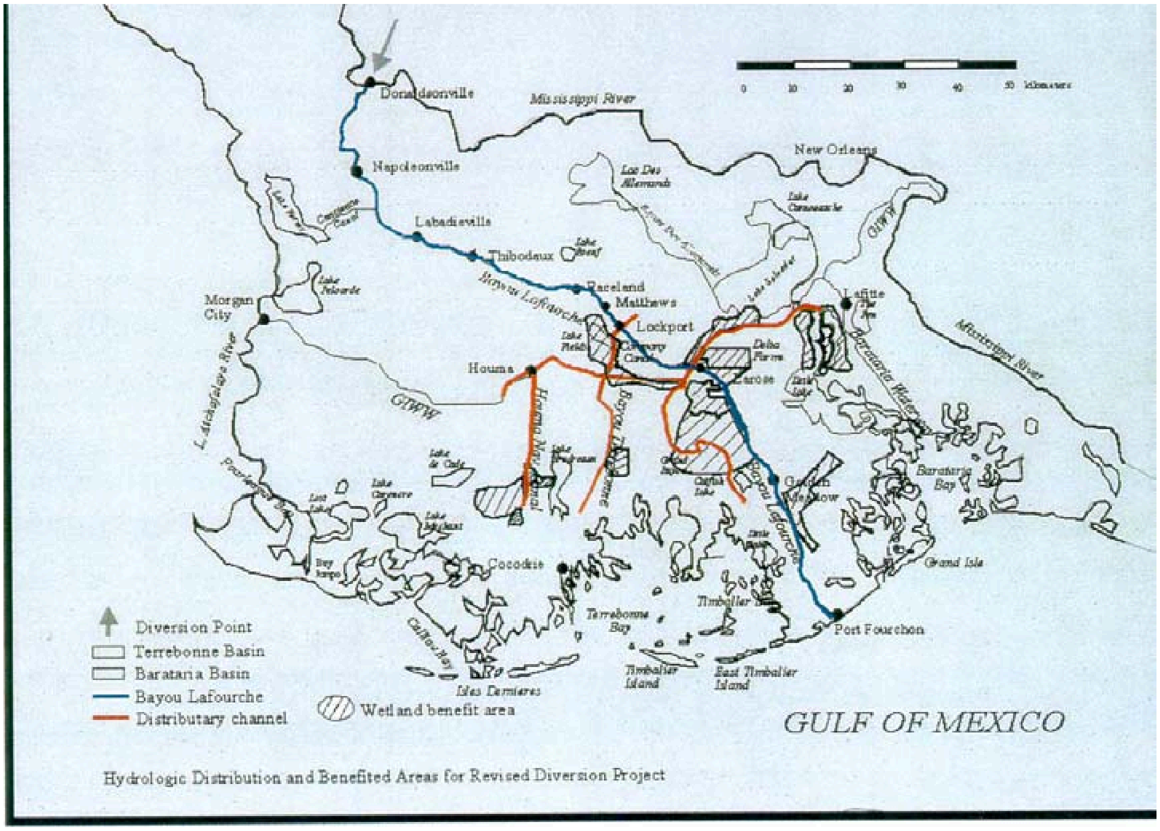

Figure 4. Project Benefit Areas

Additionally, the Bayou Lafourche project would provide important incidental benefits, which are intrinsically linked to the need to increase river flows into the distributary channel. These incidental benefits include:

- Maintaining potable water supply;
- Enhancing water quality;
- Maintaining or possibly increasing drainage capacity
- Enhancing recreational opportunities; and
- Reducing a small amount of nutrients currently being discharged into the Gulf of Mexico.

By combating saltwater intrusion, the Bayou Lafourche project would help protect valuable and threatened coastal wetlands, while also reducing the chances that municipal and industrial water supplies could be disrupted due to elevated salinity events. Because the project includes channel capacity improvements and added water control features, the project also has the potential to maintain and possibly improve drainage. Additionally, water quality would be improved by increased flushing of the bayou with river water. The state and EPA are currently in the process of revising the water quality standards for Bayou Lafourche. The project is projected to improve existing water quality, thereby possibly reducing the need for future infrastructure improvements related to National Pollutant Discharge Elimination System (NPDES) dischargers. Finally, by routing Mississippi River water through wetlands, there would be a relatively small reduction in nitrogen being discharged into the Gulf of Mexico. In this way, the project could contribute in a small way to the national goal of reducing hypoxia in the Gulf of Mexico.

Synergy with Other Restoration Projects

Consistent with the criteria for identifying critical near-term projects, a balanced approach to restoring coastal Louisiana should address both critical ecosystem processes and structures. In the case of the deltaic plain, the most important process is the connection between the Mississippi River and the estuaries, while barrier islands and shorelines serve as some of the most critical structural components of the ecosystem.

The Bayou Lafourche project would have a complementary and/or synergistic relationship with a number of past, ongoing, and future restoration projects, conducted pursuant to CWPPRA, other authorities, and, if authorized, the LCA Plan. In particular, the Bayou Lafourche reintroduction project would serve to restore to some extent deltaic processes in an estuarine complex that has benefited from a number of barrier island projects. The Bayou Lafourche project would also complement other LCA projects in the Barataria-Terrebonne estuary complex, particularly Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island and, in a more general sense, the proposed Medium Diversion at Myrtle Grove, modification of the Davis Pond Freshwater Diversion, and Multipurpose Operation of the Houma Navigation Canal Lock, a component of the Morganza to the Gulf Hurricane Protection Levee.

As noted above, the Bayou Lafourche project could have a synergistic relationship with the LCA project entitled Convey Atchafalaya River Water to Northern Terrebonne Marshes. The combined effect of the two projects could greatly reduce saltwater intrusion in the eastern Terrebonne wetlands, and could create opportunities to address other areas of critical need. Moreover, potential measures to improve distribution of Bayou Lafourche reintroduction waters (e.g., enlargement of Bayou L'Eau Bleu and/or Grand Bayou Canal) could facilitate efforts to move Atchafalaya waters into areas of critical need. Given this positive interrelationship, opportunities to maximize synergy between these two projects should be fully evaluated in the feasibility study for the Bayou Lafourche reintroduction.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived by summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

As the project is developed, more and more information will become available to refine the project design, address uncertainties, and to allow for the selection of the most favored alternative. The following is a summary of cost information based on the conceptual project of 1,000 cfs. Additional cost information has been developed from ongoing preconstruction engineering and design work conducted in the CWPPRA for a freshwater introduction at Bayou Lafourche.

The estimated cost for designing and constructing the freshwater reintroduction is $144.116 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 1. MCACES Cost Estimate, Bayou Lafourche Reintroduction

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands and Damages (Includes Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				17,000	8,500	25,500
01B30	By Govt on Behalf of LS				1,519,138	759,570	2,278,708
01B40	Review of LS				21,640	10,820	32,460
01C	Condemnations						
01C30	By Govt on Behalf of LS				72,870	36,440	109,310
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				280,000	140,000	420,000
01E50	Review of LS				72,400	36,200	108,600
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				115,000	57,500	172,500
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G10	By Government				99,925	49,960	149,885
01N00	Facility/Utility Relocations (Subordination Agreement)				55,800	27,900	83,700
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				173,525	86,760	260,285

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01R1C	By Govt on Behalf of LS				4,985,180	2,493,192	7,478,372
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				928,000	464,000	1,392,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				10,450	5,230	15,680
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				25,000	12,500	37,500
01--	Subtotal: Lands And Damages (Includes Influence Area)						8,392,928
	Contingencies						4,197,072
01--	Subtotal: Lands And Damages (Includes Influence Area)						12,590,000
01--	TOTAL: LANDS AND DAMAGES						12,590,000
02--	RELOCATIONS						
02------	Pipeline Relocations (58)	Lump Sum	LS	9,200,000	9,200,000	5,520,000	14,720,000
	TOTAL: RELOCATIONS						14,720,000
09--	CHANNELS AND CANALS						
09--	Dredging						
	Channel Dredging (6,725,000 cy)	Lump Sum	LS	30,734,000	30,734,000	18,252,720	48,986,720
	Sand Trap (90,000 cy)	Lump Sum	LS	236,125	236,125	137,155	373,280
09--	Subtotal: Dredging						30,970,125
	Contingencies						18,389,875
09--	Subtotal: Dredging						49,360,000
09--	Remove Thibodaux Weir	Lump Sum	LS	115,000	115,000	66,000	181,000
09--	Deployable Weir at Thibodaux						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Mob & Demob	Lump Sum	LS	32,400	32,400	18,792	51,192
	Rubber Dam	Lump Sum	LS	376,506	376,506	218,210	594,716
	Installation and Testing	Lump Sum	LS	1,500	1,500	870	2,370
	Foundation					0	
	Sheet Pile	9,350	SF	18	168,300	97,614	265,914
	Concrete	111	CY	400	44,400	25,752	70,152
	Excavation	75	CY	5	375	218	593
	Fill	65	CY	10	650	377	1,027
	Cofferdam (Temp sheet pile)	10,200	SF	11	112,200	65,076	177,276
	Rock Ramp	370	TN	35	12,950	7,511	20,461
	Misc.	Lump Sum	LS	9,050	9,050	5,249	14,299
09--	Subtotal: Deployable Weir at Thibodaux						758,331
	Contingencies						439,669
09--	Subtotal: Deployable Weir at Thibodaux						1,198,000
09--	Deployable Weir at Donaldsonville						
	Mob & Demob	Lump Sum	LS	37,540	37,540	21,773	59,313
	Rubber Dam	Lump Sum	LS	406,948	406,948	236,030	642,978
	Installation and Testing	Lump Sum	LS	1,500	1,500	870	2,370
	Foundation						
	Sheet Pile	11,700	SF	18	210,600	122,223	332,823
	Concrete	180	CY	400	72,000	41,760	113,760
	Excavation	450	CY	5	2,250	1,305	3,555
	Fill	130	CY	10	1,300	754	2,054
	Cofferdam (Temp sheet pile)	12,500	SF	11	137,500	79,750	217,250
	Rock Ramp	500	TN	35	17,500	10,150	27,650
	Misc.	Lump Sum	LS	9,650	9,650	5,597	15,247
09--	Subtotal: Deployable Weir at Donaldsonville						896,788
	Contingencies						520,212
09--	Subtotal: Deployable Weir at Donaldsonville						1,417,000
09--	TOTAL: CHANNELS AND CANALS						52,156,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
13--	PUMPING PLANTS						
13--	- New 660 cfs Pumping Station						
	Mob and Demob and Site Preparation	Lump Sum	LS	1,325,000	1,325,000	768,500	2,093,500
	Intake Structure	Lump Sum	LS	1,247,000	1,247,000	723,260	1,970,260
	Intake Lines	Lump Sum	LS	1,548,000	1,548,000	897,680	2,445,680
	Pump Pit Structure	Lump Sum	LS	1,333,000	1,333,000	773,140	2,106,140
	Mechanical and Electrical	Lump Sum	LS	2,265,000	2,265,000	1,313,700	3,578,700
	Discharge Pipes	Lump Sum	LS	1,466,000	1,466,000	850,280	2,316,280
	Discharge Structure	Lump Sum	LS	368,000	368,000	213,440	581,440
13--	Subtotal: New 660 cfs Pumping Station						9,552,000
	Contingencies						5,540,000
13--	Subtotal: New 660 cfs Pumping Station						15,092,000
13--	Replace Existing 340 cfs Pumps						
	45,000 gpm Variable Speed Pumps	2	EA	240,000	480,000	278,800	758,800
	Electric Motors	2	EA	100,000	200,000	116,000	316,000
	Install Pumps and Motors	2	EA	20,000	40,000	23,200	63,200
13--	Subtotal: Replace Existing 340 cfs Pumps						720,000
	Contingencies						418,000
13--	Subtotal: Replace Existing 340 cfs Pumps						1,138,000
13--	TOTAL: PUMPING PLANTS						16,230,000
16--	BANK STABILIZATION						
16--	Bulkheads (2 miles timber, 1 mile steel)	Lump Sum	LS	3,990,432	3,990,432	2,314,165	6,304,597
16--	Scour Protection at Bridges (9)	Lump Sum	LS	373,040	373,040	216,363	589,403

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
16--	Subtotal: Bank Stabilization						4,363,472
	Contingencies						2,530,528
16--	Subtotal: Bank Stabilization						6,894,000
16--	TOTAL: BANK STABILIZATION						6,894,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				11,250,000	2,250,000	13,500,000
	PED				7,497,000	1,503,000	9,000,000
	E&D				4,200,000	840,000	5,040,000
30--	Subtotal: Engineering And Design						22,947,000
	Contingencies						4,593,000
30--	TOTAL: ENGINEERING AND DESIGN						27,540,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				10,800,000	2,160,000	12,960,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						12,960,000
	TOTAL PROJECT COST						144,116,000

Monitoring the performance of the project features will be conducted as part of the construction portion of the recommended plan. The purpose of including monitoring in the project is to document the performance of the reintroduction in terms of meeting the environmental goals of the project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater introduction. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the pipes and minor construction events to maintain the performance of outfall management measures. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $1,400,000.

Table 2 provides a summary of the first costs for the LCA Plan to reintroduce Mississippi River water into Bayou Lafourche.

Table 2. Small Bayou Lafourche Reintroduction
Summary of Costs for the LCA Plan
(June 2004 Price Level)

Lands and Damages	$	12,590,000
Elements:		
Relocations	$	14,720,000
Channels and Canals	$	52,156,000
Pumping Plants	$	16,230,000
Bank Stabilization	$	6,894,000
Monitoring	$	1,026,000
First Cost	$	103,616,000
Feasibility-Level Decision Document	$	13,500,000
Preconstruction Engineering, and Design (PED)	$	9,000,000
Engineering, and Design (E&D)	$	5,040,000
Supervision and Administration (S&A)	$	12,960,000
Total Cost	**$**	**144,116,000**

A detailed breakdown of cost accounts between Federal funds and the share responsibilities of the local sponsor is provided in **table 3.**

Table 3. Small Bayou Lafourche reintroduction FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 6,750,000	$ 6,750,000	$ 13,500,000
PED (65%Fed-35%NFS)	$ 5,850,000	$ 3,150,000	$ 9,000,000
LERR&D (100% NFS)	$ -	$ 27,310,000	$ 27,310,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 66,683,500	$ 8,596,500	$ 75,280,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 3,276,000	$ 1,764,000	$ 5,040,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 8,424,000	$ 4,536,000	$ 12,960,000
Monitoring (65%Fed-35%NFS)	$ 666,900	$ 359,100	$ 1,026,000
Total Construction	**$ 84,900,400**	**$ 45,715,600**	**$ 130,616,000**
TOTAL COST	**$ 91,650,400**	**$ 52,465,600**	**$ 144,116,000**
Cash Contribution	*$ 91,650,400*	*$ 18,405,600*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Bayou Lafourche Reintroduction features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in January 2005, with completion estimated in about one year (April 2006). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in April 2006 and are forecast for completion in July 2007. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as July 2007, with construction completion estimated in March 2012.

These accelerated schedules are important for the implementation of the tentatively selected plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

Procedures necessary to comply with the NEPA have been initiated as part of the ongoing CWPPRA process for the Bayou Lafourche project. A NOI to prepare an EIS for Mississippi River Reintroduction into Bayou Lafourche was published in the *Federal Register* on March 23, 2004. In April 2004, EPA hosted five NEPA scoping meetings in Gray, Donaldsonville, Larose, Napoleonville, and Thibodaux, Louisiana. A draft EIS is being prepared to accompany the design report. During the public scoping meetings, numerous private and public stakeholders expressed strong support for this project. Indeed, a number of stakeholders expressed frustration that the project has not yet been implemented.

The information gathered as part of this ongoing NEPA process would be directly applicable to the EIS that would be prepared as part of the LCA programmatic authorization process. As required by the NEPA process, the Bayou Lafourche Project EIS will consider the affected environment including the direct and cumulative affects of the project. The engineering and environmental information developed under CWPPRA for the Bayou Lafourche Project would expedite development of both the LCA EIS and the feasibility study.

The environmental impacts of the near-term features recommended in the LCA authorization are covered in the Programmatic Environmental Impact Statement (PEIS) for the study. In addition, each specific project recommended will proceed through feasibility study for approval requiring project specific review under NEPA through a Supplemental Environmental Impact Statement (SEIS) or Environmental Assessment (EA). These environmental compliance actions will be completed in decision documents to be reviewed and approved by the Secretary of the Army.

During the plan formulation process, the LCA PDT assessed the impacts of various specific restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plans carried over for detailed analysis. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

All major environmental restoration projects come with uncertainties and risks. Thorough study and review prior to project implementation is critical for minimizing such risks and uncertainties. Effective monitoring and adaptive management (as is included as part of the LCA Study) is key for managing unforeseen consequences and maximizing project effectiveness.

As outlined above, the Bayou Lafourche project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This extensive review process has helped identify and address a number of potential questions/concerns, such as whether increased volumes of water in the bayou could cause flooding, what would occur if there is a hazardous substance spilled in the river near the reintroduction structure, and the extent to which there could be bank instability along the bayou. While the final Engineering and Design (E&D) is needed to substantively answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, as noted under the "Benefits" section of this report, the channel improvements envisioned as part of the project have the potential to increase drainage capacity.

Recommendations/Summary

The Bayou Lafourche project has been recommended for contingent authorization based on its capability to address critical ecological needs such as slowing the dramatic land loss, preserving habitat for numerous fish and wildlife species and reducing salinity intrusion. At least five years of these critical losses could be avoided by contingent authorization. The Bayou Lafourche Project will restore, to some extent, the natural distributary process in which the bayou serves as a conduit to provide Mississippi River water to coastal areas with the highest wetland loss rates in the U.S. Moreover, because this project has the potential to provide important incidental benefits to water supply and water quality, it would also serve as a model for how restoration efforts can provide immediate, near-term benefits to humans.

The Small Bayou Lafourche Reintroduction project also offers an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Because the project is currently in the process of engineering and design, it is in a unique position to move forward relatively quickly. Likewise, the logistical and environmental information gained from both the planning and implementation of the project would be invaluable to future LCA efforts. For all of these reasons, the Bayou Lafourche reintroduction project should be included in the contingent authorization category for the LCA Study.

Sources

Cost estimate provided by USACE-MVN.

U.S. Environmental Protection Agency, Region 6. September 1998. Preliminary Draft Evaluation of Bayou Lafourche Wetlands Restoration Project: Summary Report. Volume I. Unpublished.

U.S. Environmental Protection Agency and U.S. Department of Army, Corps of Engineers. April 2001. Draft Bayou Lafourche Update. www.bayoulafourche.org/client_files/editor_files/BLFrecon4_12_01_TFMtg.pdf

Medium Diversion with Dedicated Dredging at Myrtle Grove

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Medium Diversion at Myrtle Grove with Dedicated Dredging
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The Medium Diversion with Dedicated Dredging at Myrtle Grove critical near-term feature addresses both the need to preserve long-term restoration opportunities and to bring significant reversal of the wetland loss trend. In preserving long-range restoration opportunities, implementation of this feature also supports several possible outcomes of proposed large-scale studies. The immediate restoration impact of the implementation of the Myrtle Grove feature is significant in addressing predicted future wetland loss in an ecologically critical zone of habitat transition in one of the most productive estuaries in the Nation. In addition, commercial and private development at the perimeter of this basin, located to take advantage of its productivity and to support local, regional, and National economic interests, would receive incidental benefits from the restoration of these wetlands. These benefits would include continued sustainable biologic productivity in the estuary as well as the indirect benefit of reduction of storm-driven tidal stages.

Currently authorized Federal environmental projects (in this specific case, the Davis Pond Freshwater Diversion project) have been designed to sustain and stabilize the present basin wide salinity regime. This outcome falls short of the broader restoration objectives but existing projects can and will be incorporated or modified in the implementation of this feature and other future restoration efforts. In this manner, the proposed restoration feature will also support adaptive management and learning goals and provide a platform for additional learning through add-on demonstration projects.

The proposed restoration feature considers a diversion ranging from 2,500 to 15,000 cfs coupled with dedicated dredging for the creation of up to 19,700 acres of new wetlands. This combination will allow for rapid creation of wetland acreage and long-term sustainability. The diversion will allow the reintroduction of freshwater, sediment, and nutrients into the critically effected area of the basin in a manner similar to the rise and fall of the river's hydrologic cycle. The rate of reintroduction will be optimized according to the overall planning objectives of the LCA restoration effort to maintain hydro-geomorphic diversity and connectivity, as well as habitat diversity. The dedicated dredging component of the Myrtle Grove feature will allow immediate recovery of former wetland areas already converted to open water. The combination is also expected to maximize the amount of acreage created per yard of sediment placed by capitalizing on incremental accretion of diverted sediment.

Stand-alone marsh creation typically requires over-building the marsh substrate to a designated pre-settlement elevation from which the newly created marsh will settle to an optimal, tidally-influenced elevation. However, wetland soils (particularly fresher marsh types) have a high organic content as a result of their normally high vegetative productivity. The combination of marsh creation with dredged material coupled with subsequent sediment and nutrient reintroduction should reduce or eliminate the need to over-build and allow vertical accretion through accumulation of organic biomass.

The key components of the proposed feature, which will be discussed in greater detail, include:

- A gated diversion structure with a capacity of approximately 5,000 cfs
- Inflow and outflow channels totaling approximately 16,000 feet
- Associated channel guide levees and infrastructure relocation
- Identified marsh creation sites adequate for the creation of at least 6,500 acres

Description of Area/Background

Located in Subprovince 2, the project area is on the west bank of the Mississippi River in Plaquemines Parish, in the vicinity of Myrtle Grove, Louisiana (see **figure 1**). The project area is focused around the highly deteriorated marshes adjacent to the river, extending southward to central portions of Barataria Basin. The Barataria Basin is located in the following Louisiana parishes: Ascension, Assumption, Jefferson, Lafourche, Orleans, Plaquemines, St. Charles, St. James, and St. John the Baptist.

Soil borings and vibracores taken in the Myrtle Grove area indicate that this area has received deltaic sedimentation from two deltaic systems. Approximately 3,000 years ago, a major distributary of the St. Bernard Delta was actively depositing sediment into an open water setting in the Myrtle Grove area. This open water was filled with prodelta, interdistributary, and marsh deposits. After several hundred years, the St. Bernard Delta shifted away from this area and the processes of subsidence and erosion became dominant. Much of this area was converted to shallow open water, which remained until the next episode of delta progradation entered the area.

Approximately 1,000 years ago, the Plaquemines Delta began to deposit sediment in the Myrtle Grove study area. Shallow water areas were filled with interdistributary and marsh deposits. The Mississippi River has been in its present location for the past 1,000 years, and the study area continued to receive fresh water and sediment from the Mississippi River and its distributaries.

With the development of the Mississippi River levee system over the last century, once frequent introductions of sediment and nutrients were disrupted. These introductions helped the area accrete sediment and detritus, and the marshes kept pace with subsidence. Another major factor was the dredging of oil and gas and navigation canals that allowed salt water to encroach far inland, resulting in a shift from intermediate marshes to slower-growing brackish marshes. The high subsidence rate combined with these factors resulted in a rapid degradation of the marshes in the area.

In 1949, the marshes in the Myrtle Grove project area were primarily intermediate marsh (60 percent) and brackish marsh (40 percent). By 1978, the habitat had shifted almost entirely to brackish marsh. Concurrent with the shift in habitat was a period of high land loss. This was mainly due to altered hydrology, wind erosion, subsidence, and direct losses from dredging.

Loss rates continue to be high, and reflect the effects of saltwater and tidal intrusion as well as a high subsidence rate (2.1 to 3.5 ft/century).

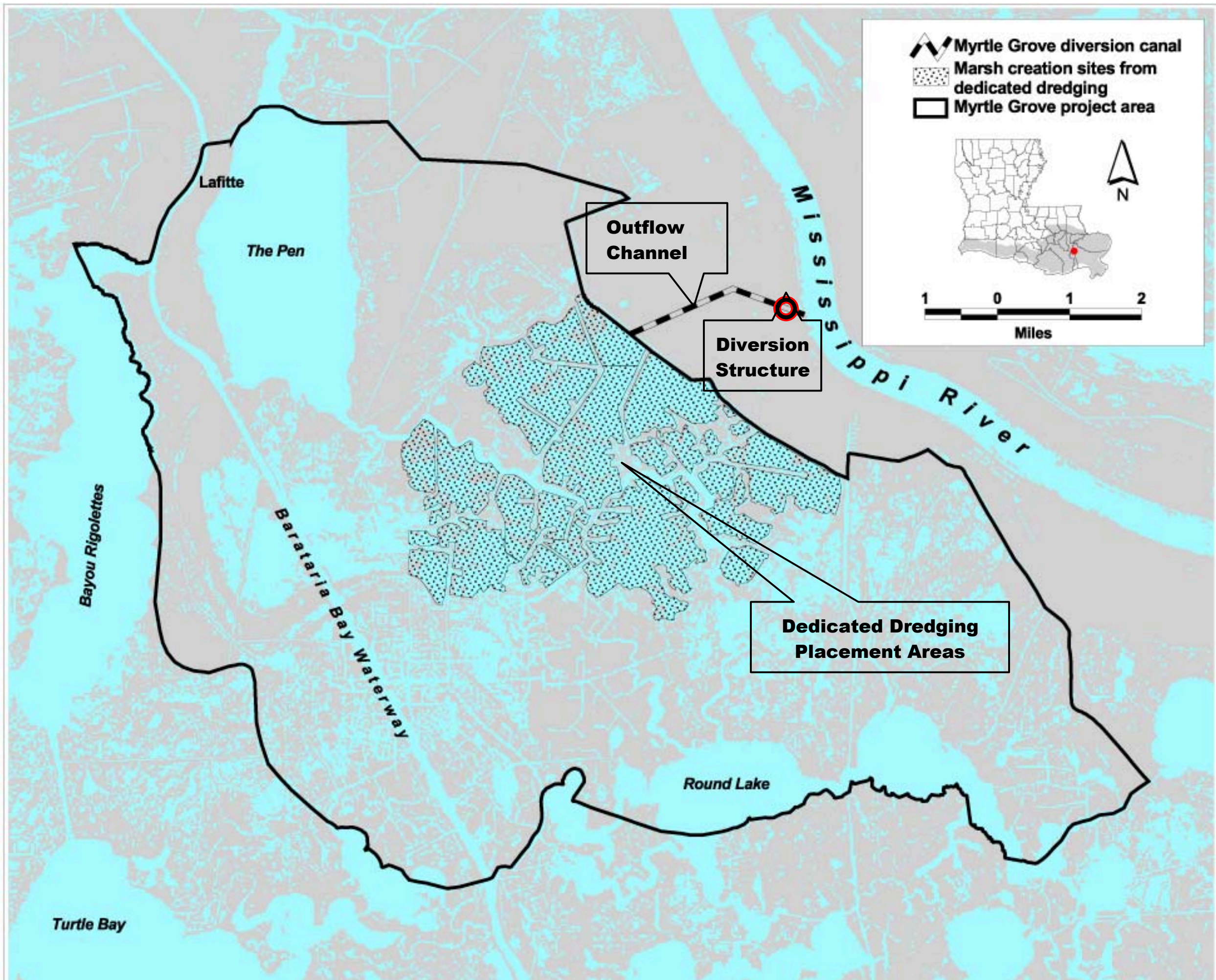

Figure 1. Medium Diversion at Myrtle Grove with Dedicated Dredging Feature Elements and Primary Influence Area

Two projects in the vicinity have helped reduce these impacts. The siphons at West Pointe a la Hache and Naomi have reduced loss rates in their project areas. A diversion in the Myrtle Grove, Louisiana area into the marshes to the west is expected to benefit the marshes as well. The scaling of the diversion would account for salinity patterns in the area, especially in conjunction with the Davis Pond Diversion, which introduces fresh water at the northern end of the Barataria Basin. This would be accomplished with a hydrologic model that would account for the interaction of these two major diversions with the isohalines in the project area.

The salinity regime is important because of the productivity of seafood in the area. The Barataria Basin is a primary fishing ground for brown and white shrimp, blue crab, spotted seatrout, menhaden, red drum, and oyster. Most of these species are estuarine dependent, and utilize the marshes for nursery habitat. Decreases in the acreage of marsh could affect recruitment of these species, as well as the abundance of their prey.

The marsh is comprised primarily of marsh-hay cordgrass and smooth cordgrass. These marshes support a great diversity of fish and wildlife, including red and black drum, spotted seatrout, menhaden, flounder, oyster, shrimp, blue crab, wading birds, shorebirds, seabirds, and alligator. The numerous bayous provide access to fish nursery habitat, and these young fish provide a base for the food chain of larger predators.

Problems and Needs

The project area is currently a sediment-starved system with little freshwater input. These factors have magnified the high subsidence in the area, resulting in massive land loss. To counteract this loss, the project area needs inputs of both sediment and water. The Davis Pond diversion provides fresh-water input to the basin to the north, but local marshes are too far removed from the diversion structure to benefit directly from the introduction of nutrients, and the salinity regime would be more controllable with a fresh-water input closer to the area of need.

A diversion from the Mississippi River would provide both resources, and would provide a relatively cost-effective way to recreate land in the project area. Nevertheless, the land accretion process is slow, and an introduction of material through dedicated dredging would provide for a marsh platform immediately. To balance the need for wetland acreage in the near-term with the ability to sustain the marshes over the long-term, various combinations of marsh creation through dedicated dredging and fresh-water introductions through a river diversion will be examined.

Without Project Conditions

Critical Need

The proposed restoration feature has the potential to prevent significant future land loss where currently predicted to occur in the central portion of the Barataria Basin. U.S. Geological Survey (USGS) data indicates that within just the immediate influence area of the feature approximately 12,900 acres have been lost since 1956. An approximate 7,900 additional acres are predicted to be lost by 2050. This represents a loss of 26.75 percent of the currently existing wetlands in the Myrtle Grove area.

This area is a transitional zone in the estuary where brackish-saline type and intermediate-fresh type marshes merge, transitioning from saline marsh to the south and into fresh marsh at the northern extent near the Gulf Intracoastal Waterway (GIWW). These transitional habitats are some of the most productive within the estuarine system supporting a wide array of both juvenile and adult fisheries species. Current habitat data for the immediate Myrtle Grove influence area indicates that 66 percent of the remaining marsh is brackish and an additional 24 percent is intermediate in nature. This is significant in contrast to the 1956 habitat classification data that identifies, in addition to there being a greater quantity of wetland acreage in the Myrtle Grove area, that of the existing acreage at that time 89 percent was fresh/intermediate and 4 percent saline/brackish in nature.

The Future Without Action conditions forecast by ecologic modeling indicates that, in the next fifty years, all saline and brackish marsh and approximately 40 percent of the intermediate marsh in the Barataria Basin will be lost. This can be attributed to lack of sediment input, and continued soil subsidence. In addition to directly resulting in wetland loss, these factors are compounded by the low success of saline vegetation reestablishing on the highly organic soils established in fresh marshes. These combined factors along with the projected hydraulic and ecologic trends in, and current make up of, the area in the vicinity of Myrtle Grove indicates that it is at particularly high risk.

The proposed feature also takes advantage of the resources available from the Mississippi River to meet study objectives (establishing dynamic salinity gradients, increasing sediment inputs, establishing and maintaining hydrologic processes, sustaining biologic diversity, and reducing nitrogen delivery to the Gulf of Mexico). Reconnecting the river to the estuary and placing river borne sediments into the system promotes long-term ecosystem sustainability. The feature also addresses the improvement of overall water quality within the basin.

The restoration of wetlands in this area will also protect and support socio-economic interests located in the central and upper portions of the Barataria basin to capitalize on the fisheries productivity of the estuary. The communities of Lafitte and Barataria represent the southernmost development in the interior of the Barataria Basin and are located outside of any existing hurricane protection works. Loss of the existing wetland structure will have an immediate impact on the sustainability of these communities. In addition, industries located along the Mississippi River in the vicinity of Myrtle Grove would also become threatened with the loss of interior wetlands in this area. Currently, there is no Federal hurricane protection levee parallel to the river in this area. The absence of this protection is due, in part, to the historic presence of the wetlands.

Projected Near-Term Loss -- *Criticalness*

There is a need to factor both discreet land loss events (such as hurricanes and drought induced dieback) as well as linear functions of erosion (subsidence, shoreline erosion, etc.) in to any projection of wetland loss. As a result of this "smoothing" of historic data into a trend, the resulting projections do not identify dramatic short-term loss potential. However, ecologic modeling projections, for no-action conditions, do estimate a loss of 119,000 acres within the entire Subprovince 2 area over the next 50 years. This simulation also estimates that approximately 24 percent of this loss would occur in the first 10 years, a rate of about 2,800 acres per year. Since the majority of the wetland loss without action is projected to occur in the areas of intermediate to saline marsh, the central area of the Barataria Basin is likely to experience significant losses in the near-term. In addition, these marsh types typically represent the most biologically diverse and productive portion of the estuary. The discreet hydrologic events mentioned previously have a significant impact on overall system loss and the rate of loss. In addition to the direct losses that result from periodic storm events, there are even greater losses associated with secondary effects of these storms and longer-term hydrologic events such as droughts. These events typically have the effect of creating drastically elevated salinity across the landscape, which results in relatively rapid plant mortality. As the coastal ecosystem becomes increasingly more deteriorated and stressed, the level of risk for rapid or accelerated loss due to such events increases at a compounded rate.

This would also indicate that the development in the vicinity of the central area of the basin would be place at more immediate risk. The presence of this development is directly related to the presence and magnitude of the natural and biologic resources found in the estuary. As the system deteriorates the resource output of the system may remain high, however, the direct risk for structure and infrastructure damage and loss also increases. Ultimately the loss of critical productive habitat and diversity will result in lost livelihoods as the resource outputs of the system diminish. Restoration of function in critically affected areas, and eventually the entire system, provides for the sustainability of diverse ecosystem resources even though the physical and spatial distribution of the resources may be altered.

Synergy with Other Restoration Projects

The recommended diversion and marsh creation feature at Myrtle Grove has links to two of the large-scale, long-range studies identified in the LCA Plan. One, the Mississippi River Delta Management study, would investigate the multiple-use management of the lower Mississippi River. This might include the relocation of current navigation routes for the purpose of making available additional river flow and sediment for restoration. Previous analysis of alternative navigation routes has identified the need to use a system of locks to manage river flow and deep draft navigation traffic effectively.

If such a concept were ultimately found feasible and recommended, the currently proposed Myrtle Grove diversion feature would support such future action. If the navigation channel were proposed for relocation into Barataria Basin, then features such as the Myrtle Grove diversion would offset increases in salinity that occur in the presence of such a deep draft channel. The conditions in the vicinity of the Mississippi River – Gulf Outlet are an example of such an adverse effect. Conversely, if future long-range studies indicate that status quo with regard to navigation and flood control is appropriate, then the near-term implementation of the Myrtle Grove diversion feature will provide critical wetland restoration and stability in the Barataria Basin.

The second large-scale, long-range study that the Myrtle Grove diversion is linked to is the Third Delta Study. This study would investigate the possible creation of a third delta-building distributary of the Mississippi River. Should such a concept be found to be appropriate in the Barataria Basin, the necessary feature development, land acquisitions and multiple feature construction could take 20 years or more to complete. Even with the completion of such a large-scale feature, current assessments indicate its effects in the northeastern portion of the Barataria Basin would be secondary in nature. Any land building in the vicinity of Myrtle Grove as a result of this major feature may take additional decades. The near-term implementation of the Myrtle Grove diversion feature is compatible with this large-scale concept and would affect direct land building in this area, restoring and maintaining the ecologically critical central basin wetlands. In addition, the near-term establishment of wetlands in the middle and eastern extent of the basin would influence future delta building in the direction of the coast, and maximize the beneficial effect of a future large-scale diversion feature by limiting the hydrologic backwater effect.

In addition to those long-range concepts to be considered, the Myrtle Grove diversion feature is compatible with other proposed critical near-term features in the area. The Davis Pond Freshwater Diversion has the capacity to influence salinities in the central portion of the Barataria Basin. However, it is not capable of building new wetlands or supplying the critically needed nutrients to the badly deteriorated area of Myrtle Grove. Coordinated operation of these two features will allow the restoration of the appropriate beneficial system function in each specific area of the Barataria estuary.

The Small Bayou Lafourche Reintroduction feature is a logical first step in attempting to direct riverine resources specifically into the wetlands of the Eastern Terrebonne Basin. However, the magnitude of the wetland loss problem dictates that means of introducing additional amounts of freshwater, sediment, and nutrients into this area will be required in the future. The LCA Plan addresses this by identifying additional critical near-term features and the investigation of the Third Delta large-scale, long-range concept. In addition, the coordinated operation of the Davis Pond and Myrtle Grove diversion features has the potential to provide additional flow to this area of the Terrebonne Basin through the GIWW. This would be input supplemental to the Bayou Lafourche reintroduction.

Alternative Investigations

The development of alternative configurations for this restoration feature stretches over a number of years. The CWPPRA planning process has identified and approved investigation of a number of possible projects at various sites in the vicinity of Myrtle Grove including: management of the existing Naomi siphon located immediately to the north of the area to optimize existing resources, restoration of the banks of the Barataria Bay Waterway to reduce tidal exchange in the area, construction of an additional siphon diversion directly into the area, creation of wetlands in the area through dedicated dredging, and finally a comprehensive evaluation study to coordinate all of these efforts as well as possible larger-scale diversion opportunities. The CWPPRA task force also funded the Mississippi River Sediment, Nutrient, and Freshwater Redistribution study (MRSNFR) to investigate and optimize the reintroduction of river resources into coastal wetlands. This study identified and developed two scales of diversion, 5,000 and 15,000 cfs, in the vicinity of Myrtle Grove. The findings of this overarching assessment of riverine potential lead to the initiation of the comprehensive evaluation study in the Myrtle Grove area. Every one of these projects or study efforts has involved initial public involvement in the decision of whether to proceed and subsequent public involvement in determining potential alternative actions. Ultimately, these efforts resulted in the inclusion of these alternative features in the LCA analysis.

Initial assessments of the proposed feature were preformed in the 2000 MRSNFR study. Some differences between the current analyses and the information provided by that study effort are the specific location of the diversion and the boundary of the primary impact area. Over the course of the various investigative efforts, several locations for a diversion in the vicinity of

Myrtle Grove have been assessed and the configuration of the primary impact area has varied slightly; however, the overall size of this area has been relatively consistent between efforts. The MRSNFR study was developed to a draft report stage and adopted by the CWPPRA Task Force as the basis for a number of diversion projects that were approved for detailed design. Many of those same projects were considered in the LCA Ecosystem Restoration study and the MRSNFR report provided the initial basis for design and cost of those features as well as a basis for scaling designs and costs for additional project alternatives.

Following the completion of the MRSNFR study and identification of real estate issues related to the potential siphon project near Myrtle Grove, the CWPPRA Task Force determined that a more comprehensive analysis of restoration options at this location be undertaken. In 2001, the task force approved the Delta Building Diversion at Myrtle Grove detailed design study, based on the potential for a small to moderate diversion project with some form of land building at this location. The initial federal sponsor of the study was the National Marine Fisheries Service (NMFS). At the request of the NMFS the Federal sponsorship of the study effort was later transferred to the USACE.

After coordination between the LCA cost-share partners, the USACE and the Louisiana Department of Natural Resources (LDNR), it was decided to proceed with the Myrtle Grove study effort. The study effort has been conducted according to USACE planning guidance for feasibility-level studies and includes the development of NEPA compliance and an Environmental Impact Statement (EIS).

<u>Screening Process (How alternatives were screened out)</u>

The current CWPPRA study of Myrtle Grove was initiated in March 2002 with the issuance of a Notice of Intent (NOI) to complete an EIS and a series of four public scoping meetings focusing on the specific problems, needs, and opportunities of the Barataria Basin (Subprovince 2) in the vicinity of Myrtle Grove. An interagency Plan Development Team (PDT) reviewed and screened the public input from the scoping meetings, identifying and formulating alternative restoration plans. These plans incorporated the previously identified CWPPRA and MRSNFR projects, as well as new feature ideas, combinations, and scales developed from the scoping input. A key commonality between all of the previously identified alternatives was their basic fit within a local ecosystem. The nature of the marsh in the vicinity of Myrtle Grove is broken and continuing to deteriorate rather than being completely open or nearly lost. As such, the alternatives developed in the previous CWPPRA and MRSNFR efforts capitalize on synergistically working with the remaining wetlands. The result of the 2002 scoping effort was a range of diversion options between 2,500 and 15,000 cfs in potential combinations with the direct creation of marsh using dredged sediments.

From this scoping effort, hydraulic and salinity modeling of the immediate Myrtle Grove outfall area was completed along with the development of potential marsh creation sites.

The scoping and formulation effort for the LCA Ecosystem Restoration study was undertaken two to three months subsequent to scoping for the Myrtle Grove CWPPRA study effort. The LCA effort also considered possible features near Myrtle Grove but did so in a larger context of restoration for an entire subprovince. As a result, the LCA formulation, while identifying alternatives similar to the current CWPPRA study, also identified large to extremely large diversions as possible alternatives at this site. Although providing a broader range of potential alternatives, this was a departure from the more location-specific problems and needs-based formulation of the CWPPRA effort. It was decided at that point that further design efforts under the CWPPRA effort should be limited to site identification, hydraulic assessments of the small- to moderate-scale diversions, and development of receiving area and marsh creation site-based data.

How we got to where we are

It was decided that the plan formulation effort under LCA would be utilized to determine the appropriate range and scale of alternatives in the Myrtle Grove area. The alternative frameworks developed for Subprovince 2 included potential diversions in the Myrtle Grove vicinity ranging from 5,000 to 150,000 cfs with various combinations of marsh creation, and sediment introduction to the diversions. Hydraulic and ecological modeling of the subprovince frameworks and a cost effectiveness analysis to develop the complete range of possible coast wide frameworks were performed. From the final cost effectiveness analysis, seven coast wide frameworks were identified as potentially complete, effective, and efficient solution sets. Six of the seven alternative coast wide frameworks included a 5,000 cfs diversion feature near Myrtle Grove. One of these six frameworks also identified the possibility of periodic pulses of higher diversion flow with the 5,000 cfs scale feature as a base. The seventh framework represented the maximum achievable output and focused on extremely large-scale diversions.

In addition, the analysis performed in the MRSNFR study was geared toward identifying the most effective and efficient means of applying the resources available in the Mississippi River to the coastal restoration effort. The study screened over seventy diversion types and scales based on potential level of direct output, the appropriateness of the expected outputs for the area being affected, and relative cost effectiveness in achieving outputs. Eleven alternative features that represented optimal combinations of type and location for diversion or reallocation of river resources were identified in an intermediate alternative array. This array included the two diversion scales identified at Myrtle Grove. A cost effectiveness and incremental cost analysis was performed on these eleven features during the MRSNFR study.

The cost effectiveness incremental cost analysis developed 1,300 combinations of the intermediate alternatives. The combinations representing cost effective solutions for achieving successive levels of environmental outputs numbered 68. Of these 68 combinations of alternatives, 12 specific combinations defined the most incrementally efficient steps of achieving the maximum outputs. In these efficient plans, the 5,000 cfs scale at Myrtle Grove appeared as the most cost effective of the diversion features analyzed. This result indicates that the most efficient mode of restoration through diversion is a small- to moderate-scale project directed into areas of deteriorated marsh. Review of the rest of the results of this analysis appears to indicate that small-scale diversion into intact but impaired wetlands would be the next most effective application of the resource. This would be followed by moderate- to large-scale diversion into highly or totally degraded areas. Moderate to large-scale diversions, such as the 15,000 cfs diversion scale at Myrtle Grove, appear more effective than extremely large-scale diversions, unless a very high level of output is required, based on the MRSNFR analysis.

As noted, the CWPPRA has identified a diversion at Myrtle Grove as a priority list project. Initial efforts to develop the project under the CWPPRA program have been initiated. However, limited program funds and identification of numerous other projects across the coast have diminished the likelihood that such a large-scale ecosystem restoration project will be completed under the program. This is evidenced as the Task Force has limited the Phase I funds provided for the project design effort and the accounting procedures no longer carry the estimated construction cost for the project. Under these circumstances, the time is appropriate to move this effort into the near-term plan for the large-scale restoration of the Louisiana coast under this study.

Recommended Plan

The results of the MRSNFR and LCA cost effectiveness analyses seem to indicate that an appropriate diversion scale, both locally and on a subprovince basis, is approximately 5,000 cfs but less than 15,000 cfs. If combined with direct marsh creation through dedicated dredging, a potentially smaller scale may be appropriate. Based on this information, it appears that the formulation in LCA, and the feature identified in the LCA Plan, is consistent with the scoping efforts of the PDT under the CWPPRA study. The formulation is therefore appropriate to support the completion of the required decision document.

The components of the proposed feature included a gated box culvert diversion structure incorporated into the Mississippi River and Tributaries (MR&T) flood protection levee. This inflow configuration would include a 2,600-foot channel with an invert elevation of –15 feet NGVD and appropriate guide levees. The outflow channel would be approximately 13,000 feet in length and also include guide levees as necessary to contain project flows. The outflow channel would transition from the –15-foot NGVD invert elevation at the diversion structure to a elevation of –5 feet NGVD at the point of discharge into the marsh. The channel width will transition proportionally from the structure to the discharge point to ensure transport of sediments. The locations of the various elements of this feature are shown on **figure 1**. Levee and highway relocations will also be required for channel construction along with accommodation of local utilities and drainage.

The creation of marsh through dedicated dredging will involve placement of material in 19 to 23 identified sites (**figure 1**) ranging in size from 10 to 1,200 acres to create a total of approximately 6,500 acres. The marsh creation will require the removal of approximately 2 million cubic yards of sediment per year from the Mississippi River. It is anticipated that this borrow area will be replenished by the river on an annual basis. Based on an estimated yield for this area of 400 acres per 2 million cubic yards, the marsh creation component of this feature will take 16 years to complete. There is no Federal navigation maintenance performed in the Mississippi River within approximately 50 miles of this feature location. Additionally, the annual amount of material projected to be removed is not expected to have a measurable effect on current maintenance efforts downstream.

Benefits

The components of this feature are intended to function synergistically to produce a rapid and sustainable response in the critical central portion of the Barataria Basin. A diversion in the range of 2,500 to 15,000 cfs should provide not only a significantly beneficial input of sediment and nutrients to the remaining wetlands in this area of the Barataria basin, but also stabilize the composition of those existing marsh classes. The currently available estimates of ecologic outputs specific to this restoration feature have been generated using the qualitative and consensus-based assessments procedures produced by the CWPPRA PDT. Higher resolution modeling efforts executed under the LCA study focused on the subprovince-wide effects of features combined to achieve outputs within specifically defined restoration frameworks. While the results of the LCA analyses provide insight into the optimal feature scales and combinations, they do not identify feature-specific outputs or benefits. However, based on the cumulative result of previous investigations and those insights derived from the LCA study effort, an advanced level of confidence in the range and magnitude of probable outputs the Myrtle Grove feature will provide can be assumed.

Based on the initial efforts from the MRSNFR study, and carried over into the LCA formulation, the estimated land building potential of the medium-scale 5,000 cfs diversion is 2,500 acres of new marsh with the potential prevention of future loss of an additional 2,500 acres. The largest scale of diversion has the potential to produce up to 6,900 acres of new emergent marsh with the potential prevention of future loss of an additional 6,300 acres. Dedicated dredging could produce up to approximately 6,500 acres of new marsh or marsh platform across the diversion influence area, further stabilizing this transitional area of the basin. The diversion will be designed and operated to support the growth and expansion of marsh created through dedicated dredged material placement to allow more efficient use of dredged material and other restoration resources. As stated in the previous section, the cost effectiveness analysis performed in the LCA study as well as various other planning efforts has pointed toward the 5,000 cfs scale as the probable optimum diversion. Based on this information, the expected benefits of this feature would be in the range of 11,500 acres at the lower end.

This estimate likely does not completely account for broader beneficial effects of salinity reduction and nutrient introduction. Comparison of the initial consensus-based PDT estimates of outputs for various subprovince frameworks versus the benefit output, based on the model analysis, has indicated that the potential for prevention of future loss is generally higher than the initial assumptions. For the Subprovince 2 frameworks, that were found in the final array of cost effective coast wide frameworks, and that included the Myrtle Grove feature, model projections of output were found to exceed initial PDT estimates by an average of 70 percent.

Additionally, operation and monitoring of the existing Caernarvon freshwater diversion has provided insight into the beneficial effects of freshwater reintroduction. Two studies investigating marsh biomass were conducted at Caernarvon by LSU and ULL researchers (Delaune 2002; Twilley 2002). The LSU study conducted a gradient analysis of the impact of the diversion on mineral and organic matter accumulation and plant biomass. The measured accretion was sufficient to offset water level rises due to subsidence. Mineral sediment input was greatest near the diversion and decreased further from the diversion. But the lower salinity at the distant sites reduced the mineral need for maintaining brackish marsh. Plant biomass increased due to nutrient addition and lower salinity and consequently enhanced marsh stability. Plant biomass also supplied matter for accretion to keep pace with subsidence. A marsh soil accretion model indicated that the marsh should remain stable for the next 100 years. The study concluded that Caernarvon diversion is stabilizing marshes and can slow or reduce marsh loss.

The ULL study investigated the significance of reduced salinity stress and increased nutrient availability at promoting soil organic matter production and promoting marsh soil formation at upstream and downstream sites. Pore water nutrients, salinity, bulk density and phosphate decreased further from the diversion. The lowered salinity and increased nutrients should slowly increase biodiversity. Controlled experiments indicated that salinity reduction alone did not increase biomass. Sediment additions increased total biomass production under conditions of low salinity. The operation of the diversion needs to deliver resources like sediment and nutrients and reduce stressors like salinity to produce optimal conditions for plant growth. The essence of these effects were integrated into the ecologic modeling tools used for LCA.

In the Breton Sound basin, as in the Myrtle Grove area, there was very little fresh and intermediate marsh habitat prior to the Caernarvon diversion. Caernarvon operations have succeeded in returning fresh and intermediate marsh to the upper Breton Sound estuary. Experience from operating the diversion indicates that water needs to sheet flow over the marsh to be beneficial. This requires 2,500 to 3,000 cfs at minimum. Higher flows could reach a greater area for a larger footprint of benefits. Also, aerial photo analysis indicates that even at high flows, water does not affect all areas equally. Some areas more conducive to flow may be receiving greater benefits than others and account for some of the variation seen in fisheries and land loss data. Pulsing of high discharge may be a strategy to maximize benefits.

The lesson learned from the Caernarvon operation and these investigations have helped to define, and support, the Myrtle Grove diversion feature being proposed.

Wetland Value Assessment Information

In addition to the analysis performed in the LCA study, benefits were previously estimated in the MRSNFR study using a community-based Habitat Evaluation Procedure (HEP) model and a new model that was developed for CWPPRA entitled the Wetland Value Assessment (WVA). Similar diversions of 5,000 and 15,000 cfs were investigated in the MRSNFR study. The results of the WVA assessments for the 5,000 cfs scale diversion provide some insight to the specific habitat related effects of the proposed diversion feature.

The WVA model is driven by the consensus professional judgment of multiple-users supported by available habitat data and user observation. This model expands upon professional judgment by formalizing user consensus, and standardization of methodology. The model does not mathematically interpolate expressions of biologic response beyond the user defined spatial extent of the project area, or sub areas, in the manner of a numeric model. In this regard, there are general understatements of the projections of beneficial output.

MRSNFR WVA for 5,000 cfs Freshwater Diversion in the Vicinity of Myrtle Grove

The project area is the brackish marshes just west and south of Highway 23 at Ironton, Louisiana (**figure 1**). This project area of this diversion was divided into Areas 1 and 2. Area 1 consists of the marshes adjacent to the river and the area most significantly affected by the freshwater diversion project. Area 2 encompasses a larger area of brackish marsh to the west and south of Area 1 and would be affected by the freshwater diversion project to a lesser degree than Area 1. The overall benefit according to the WVA in Areas 1 and 2 combined is 3,606 AAHUs for an overall benefit of 180,300 habitat units over a 50-year period.

<u>Area 1</u>

The overall net benefit is 708 AAHUs and this area encompasses 3,262 acres. Current land loss rates are approximately 1.8 percent per year. Approximately 16 percent (522 acres) is brackish marsh and 84 percent (2,740 acres) is open water. Based on a land loss rate projection of 1.8% per year, marsh acres would decrease from 522 acres at target year 0 to 202 acres (6 percent) at target year 50 without project.

The assessment team estimated wetland loss rate would be reduced for Area 1 by 85 percent from 1.8 percent to .28 percent per year for the 50-year period of analysis. This alternative had been evaluated earlier through the CWPPRA program and a WVA completed for an equivalent sized project. It was estimated in the original WVA that the wetland loss rate would be reduced by 85%. To remain consistent, the assessment team used that same value. In addition, a basic model assessment estimated that 2,454 acres of wetlands would be built over the 50-year period of analysis. An assumption was made that the additional wetlands would be built at a linear rate of 49.08 acres per year for the life of the project. Based on these assumptions and estimates, marsh acreage in the area would increase from 16 percent (522 acres) at target year 0 to 84 percent (2,745 acres) at target year 50 with project. Average salinity was estimated to increase slightly from 6 ppt at target year 0 to 8 ppt at target year 50 without project. With-project estimates indicate a freshening from an average of 6 ppt at target year 0 to 3 ppt at target year 50.

A HEP analysis preformed for specific species suggests that wildlife in general would benefit from this freshwater diversion, while fisheries species that would be impacted the most would be brown shrimp, white shrimp, and spotted seatrout. This assessment is consistent with the ecologic model outputs for species-specific habitat suitability developed in the LCA study for various subprovince frameworks. These model outputs indicated that net gains in habitat suitability could be achieved, although there would be a tradeoff in habitat between specific species. More importantly, restoration results in a net gain in total habitat due to the introduction of a wetland building function. Habitat reductions are seen in more saline fisheries species while increases are seen for fresher fish and wildlife species. A summary of the HEP analysis for the Myrtle Grove Freshwater Diversion Option performed under MRSNFR is provided in **table 1.** This MRSNFR analysis did not investigate the addition of freshwater fisheries habitat in the project area or provide a comparison of existing conditions.

Table 1. Habitat Evaluation Procedure Output
For the Myrtle Grove Freshwater Diversion Option

Species	Area 1			Area 2			Both Areas
	FWP	FWOP	Net	FWP	FWOP	Net	
Brown shrimp	15	1,755	-1,740	18,670	37,175	-18,505	-20,245
White shrimp	28	2,547	-2,518	40,797	38,953	1,844	-674
Spotted Seatrout	-	-	-	0	5,772	-5,772	-5,772
Red Drum	-	-	-	-	-	-	-
Nutria	116	24	92	1,479	1,333	146	238
Muskrat	579	120	459	7,394	6,664	731	1,190
Puddle ducks	198	41	157	2,535	2,285	251	408
Alligator	463	48	415	5,915	2,665	3,250	3,665

Area 2

Area 2 encompasses 43,582 acres and WVA analysis indicates that this project would create 2,898 AAHUs. Once again, the effect of the feature in this broader area would be to shift the balance of suitable habitats from saline toward fresh types and increase the amount of existing marsh in the future. The land loss rate at the time of analysis was measured as approximately .5 percent per year. Area 2 is approximately 49 percent (21,530 acres) brackish marsh and 51 percent (22,052 acres) open water. Based on a land loss rate projection of .5 percent per year, marsh acreage would decrease from 21,530 acres at target year 0 to 16,707 acres (38 percent) at target year 50 without project.

An initial WVA was completed previously for a similar sized project. The initial WVA estimated a reduction in wetland loss by 85 percent with project. Again, the assessment team sought to remain consistent. With-project estimates reduced the loss rate to .1 percent for the 50-year period of analysis. However, while marsh acreage was projected to show a significant increase over no-action conditions, acreage was still estimated to decline slightly from 49 percent (21,530 acres) at target year 0 to 48 percent (20,727 acres) at target year 50. No new marsh acreage is estimated to be created at this distance from the diversion site. With-project estimates for Area 2 indicate a freshening from an average of 8 ppt at target year 0 to 4 ppt at target year 50.

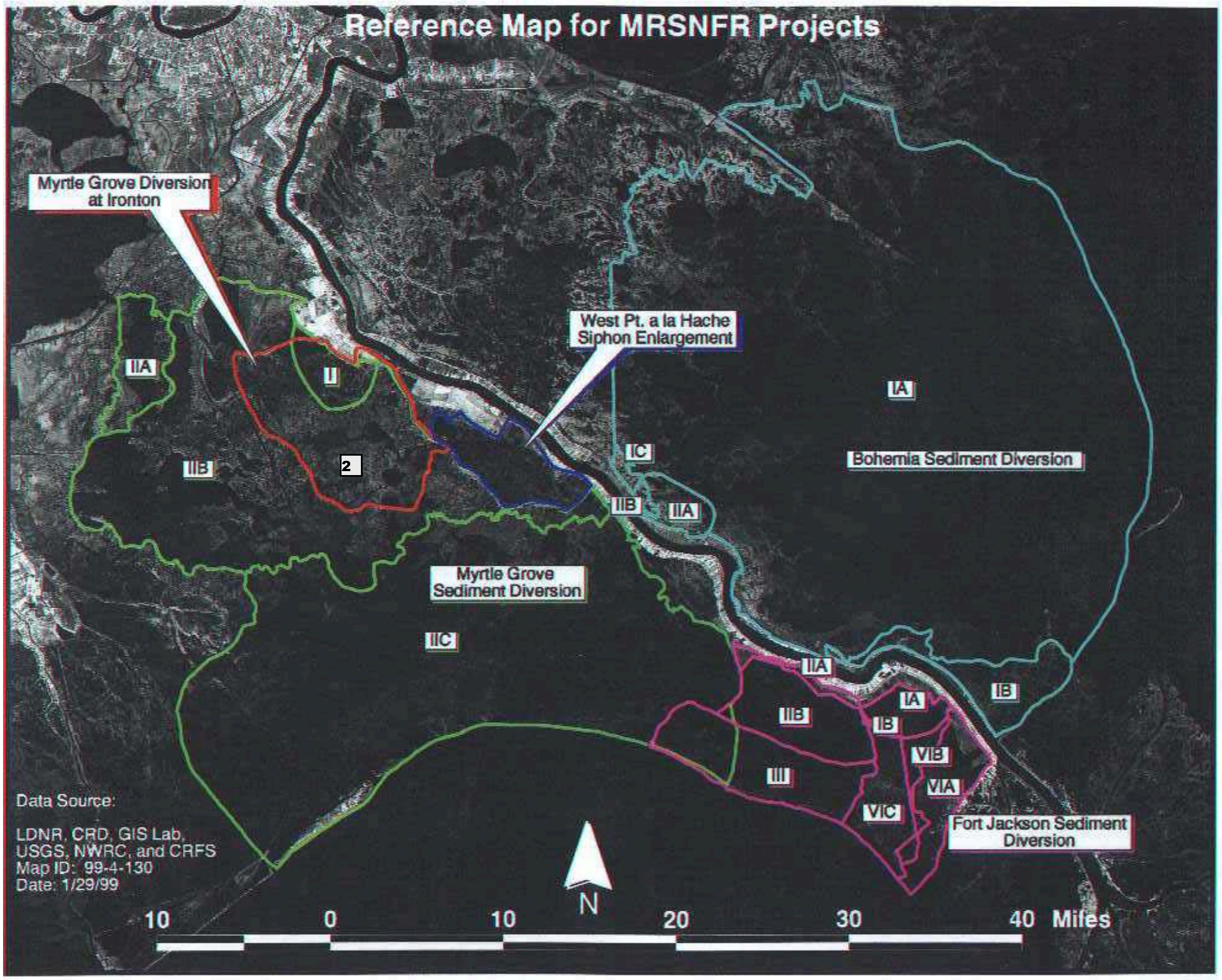

Figure 2. Wetland Value Assessment Analysis Areas from Mississippi River Sediment, Nutrient, and Freshwater Redistribution Study

Reduction of submerged aquatic vegetation (SAV) coverage was estimated to be greater for Area 1 when compared to Area 2 without action. This is due to the assumption that much of Area 1 at target year 50 without project would be open water compared to Area 2 with an estimated 38 percent marsh. Much of Area 2 would consist of small shallow ponds that would support submerged aquatic vegetation. Some fine sediment will likely pass through Area 1 and settle in Area 2. This would result in increases in the potential SAV coverage with the feature of over 100 percent in Area 1 and 200 percent in Area 2.

The HEP analysis for Area 2, shown in **table 1**, was similar to that for Area 1, except for white shrimp and alligator habitats. The project appeared to have a greater positive effect on alligator habitat in this area. White shrimp habitat appears to only be slightly affected by the project in Area 2, but is a significant reduction relative to the degree of effect indicated in

Area 1. This may be due to the fact that white shrimp can utilize fresh water more readily than brown shrimp.

Anticipated Systemic Effects on Biologic Productivity

These effects are those anticipated to occur throughout the broader Barataria Basin ecosystem as a result of this feature in the context of a cohesive restoration plan. The LCA effort has focused on identifying the optimally synergistic feature combinations and has therefore not yet produced estimates of feature specific outputs. Ecologic modeling performed in the LCA study for the supplemental framework in Subprovince 2, which included the 5,000 cfs Myrtle Grove diversion with dedicated dredging, has indicated that a relative balance between the conversion of existing habitat and the creation of new habitat is achievable. The modeling for the complete framework indicates that slight habitat reductions (less than 5 percent) would be experienced by most saline species (menhaden, white and brown shrimp) over 50 years. The inclusion of additional marsh creation through dedicated dredging would also increase marsh habitat in areas that would be conducive to white shrimp. Oyster habitat is an exception since it is heavily influenced by salinity level. Habitat for the remaining species that were assessed (bass, croaker, trout, mink, otter, muskrat, alligator, and duck) was projected to increase from 5 to 40 percent. Subsequent ecologic modeling specifically for this feature is expected to indicate that this same relative balance should be achieved in the trade-off of habitat conversion versus creation.

The effects of the Caernarvon diversion on fisheries have reflected the motility of fish species, the variation in flow patterns of the diversion, and biotic and abiotic patterns from the diversion such as food availability and salinity. Coastal fisheries production is heavily dependent on energy and primary production in estuaries. Martin's (2002) emergy analysis estimated a greater primary production and consequent fishery production at the Caernarvon and Davis Pond diversions with diversion compared to no diversion. At Caernarvon, overall finfish biomass increased 62 percent post-operation, substantiating the emergy speculations.

In addition to the expected beneficial effects on bio-productivity, the feature also meets four of the five LCA planning objectives: maintaining dynamic salinity gradients within the estuary, reestablishing the introduction of sediment from outside sources, maintaining diverse habitat and wildlife composition, and reducing nitrogen delivery to the Gulf of Mexico.

As identified previously, the 5,000 cfs scale diversion identified as the optimal scale in the LCA study should produce or prevent the loss of at least 11,500 acres in addition to beneficially affecting approximately 22,052 wetland acres per year. Based on the MRSNFR estimated average annual habitat output and the additional marsh created through dedicated dredging, the Myrtle Grove feature would produce approximately 3,606 AAHUs. The annualized Myrtle Grove feature cost, based on the cost estimate presented at the end of the next section, is $20,682,000 per year.

Engineering Design Data and Costs

Diversion design data and assumptions

Hydraulic Design

The PDT established goals and objectives for the various diversion structures designed in this study. Twenty-four locations were investigated along the Mississippi River between River Mile 177.0 just below Donaldsonville and River Mile 3.0 near Pilottown. There were 11 locations on the East bank of the river and 13 on the west bank. In general, three different-sized structures were designed for each location depending upon the planning objectives. **Table 2** contains a complete list of the alternative structures sized for the features included in the LCA Plan. The table contains pertinent design details for the various structures and is organized by the various subprovinces that would receive the diverted flows.

Types of Diversion Structures

Freshwater Diversions are designed to meet specific freshwater needs to the surrounding marshes specified by the PDT over a 50-year period of analysis. Freshwater Sediment Diversions were designed to meet specific land building requirements specified by the PDT over a 50-year period of analysis. In general, the size or design capacity of this type structure is much larger than the freshwater diversion structure because the land building objectives require very large volumes of water on a yearly basis to meet land building targets.

Design Procedure

Mississippi River gage data are available at 11 locations on the river, and reach from River Mile 302.4, Red River Landing Gage, to River Mile 10.0, Venice Gage. For this effort, all gages from the Donaldsonville gage to the Venice gage were used to develop statistics for river stages. Plate D-2 in the MRSNFR report shows the location of the Mississippi River gages in the USACE Mississippi Valley New Orleans District (MVN). The USACE-MVN district boundary contains approximately the lower 320 miles of the Mississippi River.

Period of Record

Generally, daily river gage data are available from 1935 to present. Data files are stored electronically in Hydrologic Engineering Center Data Storage System (HEC-DSS) format in the USACE's water control computers; however, the period of record used for this analysis is from 1977 to 2002. The period from 1977 to 2002 was used because 1977 marks the beginning of when the Old River Control Structure project (ORCS) began controlling the latitude flow at 70 percent/30 percent on a daily basis. In 1977, the Low Sill Control Structure, a feature of the MR&T Flood Control Project, was retrofitted with adjustable gates so that orifice flow control could be achieved. Prior to 1977, the Low Sill Control Structure's gates either operated in a fully open or fully closed position. The lack of orifice control led to conditions where a wide variance in flow occurred about the authorized 70 percent/30 percent -flow distribution. A change in the operation of the ORCS would affect the river stage statistics used in this study. The river statistics developed for this study make the assumption that the ORCS project will be operated in the future as it has been operated since 1977. It has been determined that a change in the operation requirements at Old River would necessitate Congressional approval as its operation was established in Law.

Another point concerning the MR&T Flood Control Project is that stages and discharge in the river are controlled by a system of spillways and diversion structures in the USACE-MVN. During floods, the ORCS and the Morganza Spillway are designed to limit the flow in the river to 1.5 million cfs below the Morganza Spillway. The Bonnet Carre Spillway just north of the City of New Orleans funnels an additional 250,000 cfs off the river into Lake Pontchartrain so that the discharge past New Orleans is no more than 1.25 million cfs. The implication of the flood control operation for the lower Mississippi River is that the river will never see a discharge flood event greater than about a 10-year recurrence flood event. Events greater than the 10-year event are managed with the spillway system up to the Project Design Flood, which has a recurrence interval of about once in 900 years.

Stage Exceedence Analysis

A stage exceedence analysis was done using the USACE Hydrologic Engineering Center's statistical analysis computer program for each stage recording gage in the lower 177 miles of the Mississippi River. The program uses time series data to perform several types of user specified statistical analyses. The USACE-MVN maintains a daily digital record of 8:00 AM stages for each of the Mississippi River gages used in the exceedence analysis. The stage information is contained in the HEC-DSS data format and readily usable in the STAT program. HEC-DSS data files for the period of analysis were read directly into the STAT program. The program examines the number of values or observations in the record, looks at the minimum and maximum stages for the daily values, and establishes the total range for the period of record. Since this analysis is designed to determine the percentage of observations that are equal to or greater than a particular value in the record, the program simply tracks the number of those observations and computes the percentage of the total observations that the number represents. Therefore, 100 percent of the values in the record will equal or exceed the minimum value or stage in the data set. The user specifies an interval, delta Y in feet, to increase the minimum stage, and the program recomputes and records the percentages for the stages that are greater than or equal to the new stage (minimum stage plus delta Y). The program continues to increment and record the percentage exceedence associated with each successive "new" stage until the maximum value or stage in the record is reached and at that point, zero percent of the stages in the record will equal or exceed the new value. The term 50 percent "duration" stage is used to signify the stage that is exceeded 50 percent of the time. A 0.2-foot delta Y was used in this analysis. The program can look at the entire record, yearly basis, or group the record by month and compute exceedence on a monthly basis.

Diversion	Nominal Capacity (cfs)	River Mile	Bottom Width (ft.)	Invert Elevation (ft-NGVD)	Channel Length (ft)	Type	Structure
Blind River	10,000	162.0	25	-20	25,000	Controlled	Culverts
Blind River	1,000	162.0	15	-10	25,000	Controlled	Culverts
Romeville	5,000	162.0	45	-10	15,000	Controlled	Culverts
Hope Canal/Garyville	2,100	139.6	50	-10	14,900	Controlled	Culverts
Reserve Relief Canal	5,000	137.0	45	-17	9,100	Controlled	Culverts
Reserve Relief Canal	1,000	137.0	20	-10	9,100	Controlled	Culverts
Caenarvon	150,000	76.5	500	-35	6,800	Controlled	ORC Type
White's Ditch	10,000	64.5	90	-18	8,000	Controlled	Culverts
White's Ditch	8,000	64.5	90	-15	8,000	Controlled	Culverts
Myrtle Grove	150,000	62.5	300	-45	2,600	Controlled	ORC Type
Myrtle Grove	15,000	62.5	150	-20	2,600	Controlled	Culverts
Myrtle Grove	5,000	62.5	70	-15	2,600	Controlled	Culverts

Nominal Discharge Capacity

The stage that is equaled or exceeded 50 percent of the time on a yearly basis was used in sizing the diversion structure at the various locations along the river. In general, three “nominal” discharge values were selected at each location on the river and three different-capacity structures designed for the location. For example, 2,500, 5,000 and 15,000 cfs structures were designed for the Myrtle Grove location. Therefore, when one sees the description for a 5,000 cfs structure at Myrtle Grove, the 5,000 cfs value refers to the “nominal” capacity of the structure. The structure is capable of delivering substantially more flow than its nominal capacity might infer, since the river stages for a particular location will be greater than its yearly 50 percent duration stage at least one half of the time. The converse of this statement is also true. Half of the time the structure will pass less than 5,000 cfs and for some structures, when river stages are very low, the structure will not pass any flow from the river into the receiving area.

Hydraulic Design of Freshwater Diversion Structures

To design a diversion structure, it is first necessary to know the headwater or river stages that are available at the proposed diversion site. Since most of the proposed diversion sites in the study did not fall exactly at a gage site, linear interpolation between gages was done to establish the stage statistics at the location in question. As previously mentioned, , the yearly 50 percent exceedence stage was used to design the freshwater diversion structures. Topographic USGS quadrangle maps at a scale of 1:24,000 were used to estimate ground surface elevations and approximate length of culverts necessary to pass water through the levee system and any adjacent roads or railroads. Culvert design was done using standard procedures for a culvert flowing at capacity. Since the headwater elevation and energy grade are controlled by the Mississippi River stage, head requirements dictated tailwater elevations needed convey the specified flow. In general, trial and error backwater calculations are necessary to arrive at an optimum design between channel size and structure size. This procedure was facilitated by the use of the HEC-RAS computer program. Procedurally, the topographic maps were used to layout a proposed channel alignment. Natural ground surface elevations were estimated from the maps and cross sections were cut perpendicular to the proposed channel alignment. HEC-RAS channel improvement routine was used to size the channel needed to convey the design flow to the receiving area and satisfy tailwater requirements at the proposed structure. Channel invert elevation and bottom width were varied to arrive at the necessary channel size for tailwater constraint. Channel side slopes were assumed to be 1 vertical unit on 3 horizontal units and invert slope was assumed to be flat. Manning’s “n” value for the channel was assumed to be 0.03. HEC-RAS channel improvement routine also has the capability to compute estimates of the channel cuts necessary to construct the proposed channel. In general, the process for designing an optimal combination of structure size and channel size to minimize costs is a laborious process. In this study, considerable professional judgment was employed to produce the numerous designs needed in the relative short design schedule. Designs presented in this report are considered to be of a reconnaissance scope but are believed to be appropriately-sized to meet delivery requirements, albeit not completely optimized for total project cost.

Hydraulic Design of Controlled Sediment Diversion Structures

Procedurally, the design for the sediment diversion structures was done as previously described. No specific consideration was given to whether the diversion was for freshwater or sediment. Culvert design was done using standard procedures for a culvert flowing at capacity.

For the large controlled diversions, in excess of 110,000 cfs, a structure similar to the Old River Auxiliary Control Structure was considered appropriate. The Hydraulic Design Charts, sheets 320-8 and 32-8/1 were used to compute the discharge per gate for the available head. These charts can be found at the following web site: http://chl.wes.army.mil/library/publications/hydraulic_design_criteria/. The gate sill elevation was set at –35 feet NGVD. This sill elevation would allow for the necessary freeboard for the MR&T flood control as well as encourage some of the courser sediment bed material load to pass through the control structure. The maximum number of gates was based on the total sediment required for the 50-year period of analysis.

Hydraulic Design of Uncontrolled Sediment Diversion Structures

Procedurally, the design for the sediment diversion structures was done as previously described in the section titled Hydraulic Design of Freshwater Diversion Structures. No specific consideration was given to whether the diversion was for freshwater or sediment.

Geotechnical Investigations

Based on available subsurface information and the geologic, slope stability and pile capacity information was provided for numerous locations where diversion structures were to be estimated. Where shoreline erosion control structures were to be considered, structure side slopes and construction losses due to foundation conditions were estimated based on available foundation data, general geology information, and experience in the coastal area.

Under the MRSNFR study, two geologic profiles were constructed, one paralleling the river and another perpendicular to the river. Natural levee deposits overlie the entire area parallel to the river. The profile perpendicular to the levee was constructed mainly with data extrapolated from geologic maps and nearby borings. Perpendicular to the river, natural levee deposits are located at the river's edge to approximately 1,900 feet from the river, where marsh deposits overlie the area. Natural levee deposits consist of inter-bedded, very soft to stiff, fat and lean clay with occasional layers and lenses of silt. Natural levee deposits average 15 feet thick and range in elevation from 6 to -14 feet NGVD. Marsh deposits consist of interbedded very soft, organic fat clay and peat. Marsh deposits average 14 feet thick and range in elevation from 3 to -14 feet NGVD. Swamp deposits underlie natural levee deposits except in places where swamp deposits underlie natural levee and marsh deposits. Swamp deposits consist of interbedded soft to stiff, organic fat clay with wood and occasional layers and lenses of peat and lenses of silt. These deposits average 12 feet thick and range in elevation from -5 to -28 feet NGVD. Interdistributary deposits underlie swamp and marsh deposits and consist of interbedded very soft to medium fat clay with occasional layers and lenses of silt and soft, lean clay and lenses of silty sand. These deposits average 36 feet thick and range in elevation from -14 to -61 feet NGVD. Prodelta deposits underlie the interdistributary deposits and consist of homogeneous medium to stiff fat clay with occasional lenses of medium lean clay. Prodelta deposits average 50 feet thick and range in elevation from -54 to -110 feet NGVD. Near-shore gulf deposits underlie prodelta deposits and consist of interbedded sand, silty sand, and silt with shell fragments and occasional layers and lenses of medium to stiff fat and lean clay. Near-shore gulf deposits average 11 feet thick and range in elevation from -104 to -120 feet NGVD. Pleistocene deposits underlie near-shore gulf deposits and consist of interbedded, oxidized, stiff to very stiff fat and lean clay, sand, silty sand, and silt. The surface of the Pleistocene deposits averages -120 feet NGVD in elevation and these deposits extend to an unknown depth.

Structural Design

The procedure for determining cost estimates for the various structural features for each subprovince is presented in the following paragraphs.

Subprovinces 1 and 2. The information provided from the USACE Hydraulics Branch, such as project location, structure type, structure size (number of openings, size of openings, length of culvert), fell into three categories of projects: large diversion (Old River Auxiliary Structure); box culverts (Davis Pond); and siphons (Hero Canal). The main cost estimate items were taken from the feasibility reports for each of these projects. The quantities for each of these items was determined based on the following assumptions:

- Natural ground elevation taken from USGS topographic maps
- Mississippi River flood protection elevation based on nearest river mileage
- All excavations have side slopes of 1 vertical unit on 6 horizontal units

Rudimentary designs were performed to establish the nominal dimensions of major structural components and high cost items. These rudimentary designs were based on proven concepts and historical data. Items deemed as not critical to the overall estimate were sized by engineering judgment, relying heavily on the experience of the designer. Because of the large range of diversion sizes being considered (2,500 to150,000 cfs) the design team selected the best available existing design information to reflect the breadth of the designs needed as a starting point. This happened to be the 15,000 cfs scale diversion investigated under the CWPPRA / MRSNFR study efforts.

Myrtle Grove Diversion Structure – 15,000 cfs.

The structure used for this project feature was modeled after the Davis Pond Diversion Structure. The diversion structure is compromised of inflow, gate, box culvert, downstream bulkhead, and outflow monoliths. A brief description of each portion is presented in the following paragraphs. The invert for the structure is at elevation –20 ft NGVD. Natural ground was assumed to be at elevation +5.0 ft NGVD.

A cofferdam will be required to maintain the Mississippi River flood protection during construction of the structure. The top of the cofferdam and the adjacent mainline Mississippi

River levee are at elevation +16.5 ft NGVD. A cellular cofferdam was assumed for cost estimating purposes.

The inflow portion of the structure is founded on 14-inch x 14-inch prestressed, precast concrete piles. Steel sheet pile provided for erosion protection follows the outside perimeter of each monolith.

The gate monolith houses five vertical, cast-iron, flush-bottom sluice gates and accompanying machinery. The monolith is founded upon 14-inch x 14-inch prestressed, precast concrete piles and supports the flood side toe of the main line levee. Steel sheet piling is provided along the front sides of the monolith for seepage cut-off. A walkway extends from the top of the levee to the top of the tower, providing access to the electrical equipment room and gate operating machinery.

The main body of the structure is composed of box culvert type monoliths. Each of the five culverts is a 20-ft by 20-ft chamber. The overall length of the box culvert structure is 300 feet. The culvert supports the main line levee. The monoliths are founded upon 14-inch x 14-inch prestressed, precast concrete piles. A seepage cut-off wall spans across the top of the entire structure.

The downstream bulkhead monolith is comprised of two sections. The first is, in part, a typical box culvert, with provisions for placing the downstream bulkheads. The second portion is a reinforced concrete U-frame. The monolith is founded upon 14-inch x 14-inch prestressed, precast concrete piles. The bulkheads used placed in this monolith will be constructed from structural steel. The bulkheads will be used for maintenance dewatering and emergency closures. The bulkheads will be stored on a rack at the outflow channel end of the structure.

The outflow portion of the structure is founded on 14-inch x 14-inch prestressed, precast concrete piles. Steel sheet pile provided for erosion protection follows the outside perimeter of each monolith.

The inflow channel and outflow channel will be lined with riprap. A four-lane highway bridge will be required where the outflow channel crosses Louisiana Highway 23.

Civil Design

One alternative for marsh creation and/or preservation is diverting water off the Mississippi River and route the freshwater to areas devastated by saltwater intrusion. Both controlled and uncontrolled diversions were analyzed in this study effort. The diversions varied greatly in magnitude and designs were performed for flows between 2,000 cfs to 200,000 cfs. Most locations had multiple flow-rates to bracket a range of costs and benefits to facilitate the planning process. The USACE-MVN has completed diversion projects, and design information from projects such as Davis Pond was crucial in determining quick turnaround Phase 2 costs. A breakdown of the analysis by study phases is summarized in the following paragraphs.

Phase 2 input from the USACE Hydraulics Branch included a location on the river for the proposed location and an area of flow required to develop the desired flow-rate of freshwater into the target system. Using approximate elevations from USGS topographic maps, presented in **table 3**, a quick determination of channel excavation, parallel flood protection, and scour protection was determined.

Table 3. Existing Elevations for Projects Taken from USGS Topographic Maps For LCA Plan Features and Alternatives

Proposed Alternative	Channel Length to Target Area (feet)	Existing Elevation (feet)	Water Elevation (feet)	Channel Velocity (feet/second)
Blind River	25,000	6	7.9	5.0
Hope Canal	15,900	7	10.9	13.2
Reserve Relief	9,100	7	10.9	13.2
N. Myrtle Grove 150k	13,200	12		
N. Myrtle Grove 15k	13,200	12		
N. Myrtle Grove 5k	13,200	12	6.31	8.74
S. Myrtle Grove 150k	2,800	12	2.5	7.24
S. Myrtle Grove 15k	2,800	12		
S. Myrtle Grove 5k	2,800	12	6.31	8.74
Caernarvon	6,800	6	10.9	13.2
Romeville	15,000	8	10.9	13.2
White's Ditch	8,000	1	1.91	3.65
Convent	15,000	6		

Levees

Flood protection is required along the proposed channel. For the analysis, assumptions were made as to quality of borrow material and foundation strengths. All borrow material will be removed from the proposed diversion channel site. A 10-foot crown was placed on the levees with slopes of 1 vertical unit on 4 horizontal units. A settlement factor of 30 percent was added. Cofferdams at the river and structural excavation are included in the structure cost estimates. The basic design data utilized is presented in **table 4**.

Table 4. Levee Information According to LCA Plan Feature Alternative

Proposed Alternative	Levee Height (feet)	Offset Bench (feet)	Fert/Seed (acre)	Levee Quantity (cy)	Armor Length (feet)	Armor Quantity (ton)
Blind River	10	300	51.7	1,203,704	1000	30,166.7
Hope Canal	6	300	21.2	312,347	500	12,666.7
Reserve Relief	6	300	12.1	178,764	500	14,750.0
N. Myrtle Grove 150k	10	300	27.3	635,556	1000	107,000.0
N. Myrtle Grove 15k	10	300	27.3	635,556	1000	57,000.0
N. Myrtle Grove 5k	10	300	27.3	635,556	1000	38,666.7
S. Myrtle Grove 150k	10	300	5.8	134,815	1000	107,000.0
S. Myrtle Grove 15k	10	300	5.8	134,815	1000	57,000.0
S. Myrtle Grove 5k	10	300	5.8	134,815	1000	38,666.7
Caernarvon	10	300	14.0	327,407	1000	179,000.0
Romeville	8	300	25.5	485,333	1500	35,250.0
White's Ditch						
Convent	8	300	25.5	485,333	1000	23,500.0

Four levee configurations were analyzed under the MRSNFR study effort - an all-earth levee, an uncapped sheetpile I-wall, a fabric-reinforced levee, and a combination fabric reinforced levee with I-wall. The guide levees will be constructed parallel to the channel to tie-in the Mississippi River mainline levee to the diversion structure. The alternative levee configurations were assessed to determine cost effectiveness and the most timely method to achieve design height and allow the start of operation.

Diversion Channels

Proposed diversion channel design dimensions are provided in **table 5**.

Table 5. Proposed Channel Dimensions for LCA Plan Alternatives

Proposed Alternative	Channel Bottom Width (feet)	Channel Invert Elevation (feet)	Channel Slope Run	Channel Length (feet)	Dredging Quantity (cy)
Blind River	25	-20	3	25,000	1,275,926
Hope Canal	50	-10	3	15,900	698,776
Reserve Relief	45	-15	3	9,100	644,280
N. Myrtle Grove 150k	300	-45	3	13,200	12,489,644
N. Myrtle Grove 15k	150	-20	3	13,200	3,212,978
N. Myrtle Grove 5k	70	-15	3	13,200	1,357,644
S. Myrtle Grove 150k	300	-45	3	2,800	2,649,319
S. Myrtle Grove 15k	150	-20	3	2,800	681,541
S. Myrtle Grove 5k	70	-15	3	2,800	287,985
Caernarvon	500	-35	7	6,800	7,799,096
Romeville	45	-8	3	15,000	341,333
White's Ditch	90	-15	3	8,000	654,222
Convent	45	-10	3	15,000	341,333

<u>Local drainage</u>

Because the proposed diversion channel would bisect an impounded area, local drainage must be accommodated. Under a CWPPRA priority project investigation of a small siphon, diversion work was preformed under contract to assess the effectiveness and design of inverted siphons under the proposed diversion channel. The inverted siphons could deliver local storm runoff to an existing privately operated pump station.

A pump station to accommodate local drainage was also analyzed under the MRSNFR study. The pump design should be capable of pumping 750 cfs from a drainage canal, over a levee, and into the marsh area. The maximum head against which the station would have to pump was estimated to be approximately eight feet. The station design assumed a pile-founded structure built in the dry in a dewatered open cut excavation. The pumps and motors would be housed in a weather-tight building above a concrete sump area. Dewatering bulkheads were to be included along with trash racks to prevent floating debris from damaging the pump intakes.

Relocations

Pipeline relocations were identified and relocation costs were developed for as many measures as possible. Information on pipeline locations was taken from existing maps. Estimates were developed by identifying the number and size of affected pipelines and determining the affected length. It was assumed that all pipelines would be relocated through directional drilling.

Additional detailed analysis of relocations was performed under the MRSNFR study. Relocation data was developed using the "1990 Louisiana Parish Pipeline and Industrial Atlas," various oil and gas maps, USGS topographic quadrangle maps, and aerial photographs. Several field trips were made to verify this data. Contact was made with owners to obtain detailed information for use in generation of preliminary in-house relocation plans. Estimates for relocation of highways, utilities, and power and communication lines for the proposed projects include 8 percent for owner's engineering, 6 percent for owner's contract administration, and 25 percent for contingencies. The typical relocations required in the Myrtle Grove area were identified and are discussed in the following paragraphs.

Railroad Easements (1).

A railroad easement currently exists approximately 460 feet west of the Mississippi River. There is no railroad track present, but Plaquemines Parish may install a track and activate the line to service a coal terminal south of Myrtle Grove. No time frame has been established for installation and subsequent activation of this track; however, the existing railroad easement passes through the alignment of the proposed diversion project, and therefore will be accommodated in future design. Future government participation in installation and activation of the railroad line cannot be determined at this time.

Highways (1).

Louisiana Highway 23 is a 4-lane, concrete, primary highway. Lane and shoulder widths are 12 and 10 feet, respectively. Louisiana Highway 23 traverses the proposed diversion project and will require relocation.

Pipelines (1).

A 20-inch water main belonging to Plaquemines Parish, and operated and maintained for the parish by Professional Services Group, Inc., runs parallel to and east of Louisiana Highway 23, crossing the proposed alignment of the diversion project outfall channel. The water main will require relocation.

Power and Communication Lines (4).

Electrical service is provided by Entergy Louisiana, Inc.; telephone service is provided by BellSouth Telecommunication Inc.; and cable service is provided by Plaquemines Cable Co. Aerial electrical, telephone and cable television service lines run parallel to and east of Louisiana Highway 23. Service on the west side consists solely of aerial electrical lines. On both sides of Louisiana Highway 23, support for power and communication lines is provided by power poles located approximately 250 feet apart. In all instances, the power poles, power lines, and communication lines travel across the proposed diversion project. This, coupled with the relocation of Louisiana Highway 23, will eliminate maintenance access to and require the relocation of the lines.

Cost Estimates

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived by summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described in the preceding paragraph, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The cost estimates for the LCA study features were based on existing design cost estimates for similar type features completed at feasibility- to reconnaissance-level. These available estimates were used to scale additional estimates of features for which no previous design efforts had been completed prior to the LCA study. The majority of the project features in the LCA Comprehensive Study fall into several major categories: diversions, control structures, barrier island work, shore/bank protection, and marsh creation. Costs from existing studies or projects were used whenever possible (CWPPRA, MRSNFR, Mississippi River Phase 3, Land

Loss and Marsh Creation Feasibility, etc.) and updated where necessary. The cost estimates are at a pre-reconnaissance level because of the expedited time schedule and limited or non-existent design information.

The underlying construction features of the various potential projects fall into five major types of construction common to the USACE-MVN:

- Channels
- Levees
- Structures – diversions (large, box culverts, siphons), locks, control structures
- Dredging – channels, beach nourishment, and marsh creation by pipeline and/or hopper
- Rock – dikes, jetties, paving, weirs

For those measures for which quantities were developed, USACE-MVN cost engineers developed unit costs based on available data, current labor and equipment, in-house knowledge and experience, or USACE-MVN historical data for similar type work. All of the construction work (e.g., excavation, embankment, concrete placement, rock, dredging, etc.) is common to USACE-MVN. The primary line items of work (not unit costs) of the cost estimates were developed from the feasibility reports or designs for each of the following projects.

- Large diversion (Old River Auxiliary Structure)
- Box culvert diversion (Davis Pond)
- Siphon diversion (Hero Canal)
- Locks (Bayou Sorrell Lock Replacement)
- Navigable Gated Structure (Morganza to the Gulf - Bayou Grand Caillou Sector Gate)
- Rock structures (existing breakwaters, terminal groins (jetties), and foreshore dikes)

<u>Contingencies</u>

The contingency was developed based on the degree of uncertainties in both quantities and unit prices due to the expedited time schedule and limited or unavailable design information. Contingencies were based upon similar cost estimates that had a risk analysis performed using a range estimating computer program, experience, historical data, or regulation. Contingencies of 30 percent were used for all new estimates.

Sediment Delivery via Pipeline Design Data and Assumptions

The USACE-MVN has completed many of these projects by hydraulic transport via a cutter-head suction dredge with pipeline transport of sediment in a fluid mix to the target area. A breakdown of the analysis by study phases is summarized in the following paragraphs.

The analysis assumed limited pipeline lengths of 25,000 ft per pumping plant. Borrow areas in the Mississippi River extended from one mile upstream and one mile downstream of the pipeline crossing point into the adjacent wetlands. Pipelines could be moved within the marsh area with marsh equipment. An additional booster would require enormous flotation requirements that might be deemed economically or environmentally undesirable. Borrow area assessments did not include a calculation of available material above the stability line for the levee, revetments and docks near the borrow area, and concerns for operating a hydraulic dredge in the vicinity of high traffic areas.

Field investigations of individual target areas were not performed. Variables at each site that would affect the magnitude of fill required to construct the desired wetland include surveys, existing vegetation, soil type, and moisture content of existing substrate. Design calculations assumed an optimum target of 70 percent land and 30 percent open water.

Standardized estimating criteria

Assumptions included: 3 feet of fill is required to construct to the elevation of adjacent wetlands; 100 percent of material placed in bottom 2 feet will remain; 90 percent of third foot of lift will remain while 10 percent of material bleeds into adjacent marsh. Based on these assumptions, an acre of broken marsh will require 5,000 cy/acre marsh of fill.

The USACE Cost Engineering Branch developed a matrix for dredging costs based on typical pumping distances, which are presented in **table 6**. The costs are based on the following assumptions:

1. Minimum quantity per contract is 2 million cubic yards.
2. Eight foot face available over a 500 foot swing.
3. Pipeline and boosters are available to perform work within a reasonable radius to the project site with average pipeline length shown in **table 6** as “pumping distance.”
4. Borrow material is silty sand, maintenance material.

Table 6. Dredging Costs Based on Pipeline Lengths

Pumping distance (feet)	**Unit Cost** ($/cubic yard)	**Mobilization/demobilization** ($)	**Boosters** (each)
5,000	0.80	550,000	0
10,000	0.90	750,000	0
15,000	1.20	800,000	0
20,000	1.40	950,000	0
25,000	1.55	1,250.000	1
30,000	1.70	1,450,000	1
35,000	1.95	1,550,000	1
40,000	2.25	1,750,000	1
45,000	2.30	2.100,000	2
50,000	2.55	2,350,000	2
60,000	2.85	2,950,000	3
65,000	3.30	3,050,000	3

Table 7 shows the minimum and maximum pipeline lengths for dredge placement sites considered under LCA. Some effort was made to utilize best access routes. Access routes for pipeline should be field verified.

Table 7. Minimum Pipeline Lengths for Each Site

Target Area	**Minimum Pump Distance** (miles/feet equivalent)	**Maximum Pump Distance** (miles/feet equivalent)
SW Big Mar	15,840	26,400
Golden Triangle	42,240	63,360
Myrtle Grove	13,200	60,720
Empire	5,280	58,080
Bastian Bay	2,640	34,320
Fort Jackson	10,560	36,960
American Bay	5,280	52,800
Quarantine Bay	7,920	58,080
Fort St. Philip	5,280	26,400
Labranche	15,840	36,960
Central Wetlands	10,560	52,800
Sediment Trap East	0	21,120
Sediment Trap West	0	21,120

For the diversion structure and related features at Myrtle Grove, additional detailed design and cost information was available from the CWPPRA / MRSNFR study efforts. This feature was used as a design guide for other features being considered. The detailed cost estimate information is presented in MCACES format in the following paragraphs.

Dedicated dredging for marsh creation design assumptions

General

Problems include target areas void of existing barriers, target areas outside the reach of traditional hydraulic dredge created wetlands, and limitations on available borrow sites. An example of target areas void of existing barriers includes sediment flow that crosses the Barataria Bay Waterway on the Myrtle Grove influence area.

Pipeline lengths were limited to 25,000 ft per pumping plant. Borrow areas in the Mississippi River extended from one mile upstream and one mile downstream of the crossing into the adjacent wetlands. Pipelines can be moved within the marsh area with marsh equipment. An additional booster would require enormous flotation requirements that might be deemed economically or environmentally undesirable. The borrow area did not include a calculation of available material above the stability line for the levee, revetments, and docks near the borrow area, and concerns for operating a hydraulic dredge in the vicinity of high traffic areas.

Assumptions included: 3 feet of fill is required to construct to the elevation of adjacent wetlands; 100 percent of material placed in bottom 2 feet will remain; 90 percent of third foot of lift will remain while 10 percent of material bleeds into adjacent marsh. Based on these assumptions, an acre of broken marsh will require 5,000 cy/acre marsh of fill.

The USACE Cost Engineering Branch developed a matrix for dredging costs based on typical pumping distances, which are presented in **table 8**. The costs are based on the following assumptions:

1. Minimum quantity per contract is 2 million cubic yards.
2. Eight foot face available over a 500 foot swing.
3. Pipeline and boosters are available to perform work within a reasonable radius to the project site with average pipeline length shown in **table 8** as "pumping distance."
4. Borrow material is silty sand, maintenance material.

Table 8. Dredging Costs Based on Pipeline Lengths

Pumping distance (feet)	**Unit Cost** ($/cubic yard)	**Mobilization/ demobilization** ($)	**Boosters** (each)
5,000	0.80	550,000	0
10,000	0.90	750,000	0
15,000	1.20	800,000	0
20,000	1.40	950,000	0
25,000	1.55	1,250.000	1
30,000	1.70	1,450,000	1
35,000	1.95	1,550,000	1
40,000	2.25	1,750,000	1
45,000	2.30	2.100,000	2
50,000	2.55	2,350,000	2
60,000	2.85	2,950,000	3
65,000	3.30	3,050,000	3

This project is predicted to create/preserve 6,563 acres over the next 50 years. The estimated cost for designing and constructing the Myrtle Grove Diversion and Dedicated Dredging feature is $293.962 million (including monitoring). **Table 9** provides a detailed MCACES format cost estimate for the proposed restoration features.

Table 9. MCACES Format Cost Estimates,
Medium Diversion with Dedicated Dredging at Myrtle Grove

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Channel and Structure						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500
01B30	By Govt on Behalf of LS				88,680	44,340	133,020
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				4,138	2,070	6,208
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				9,600	4,800	14,400
01E50	Review of Contract				3,200	1,600	4,800
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				4,568	2,304	6,872
01N00	Facility/Utility Relocations (Subordination Agreement)				250	130	380
01R	Real Estate Payments						
01R1	Land Payments						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01R1C	By Govt on Behalf of LS				4,998,000	2,499,000	7,497,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				6,000	3,000	9,000
01--	Subtotal: Channel and Structure						5,146,646
	Contingencies						2,573,354
01--	Subtotal: Channel and Structure						7,720,000
01-	LANDS AND DAMAGES						
	Influence Area						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				125,000	62,500	187,500
01B30	By Govt on Behalf of LS				18,891,713	9,445,860	28,337,573
01B40	Review of LS				12,400	6,200	18,600
01C	Condemnations						
01C30	By Govt on Behalf of LS				951,000	475,500	1,426,500
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				2,830,000	1,415,000	4,245,000
01E50	Review of LS				944,000	472,000	1,416,000
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				6,000	3,000	9,000
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G30	By Government				352,000	176,000	528,000
01N00	Facility/Utility Relocations (Subordination Agreement)				112,000	56,000	168,000
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				866,800	433,400	1,300,200
01R1C	By Govt on Behalf of LS				22,260,735	11,135,292	33,396,027
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				60,000	30,000	90,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				11,400	5,700	17,100
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				70,000	35,000	105,000
01--	Subtotal: Influence Area						47,510,048

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Contingencies						23,759,952
01--	Subtotal: Influence Area						71,270,000
01--	TOTAL: LANDS AND DAMAGES						78,990,000
02--	RELOCATIONS						
02031815	Pipeline Relocations	Lump Sum	LS	410,000.00	410,000	120,000	530,000
0201----	Roads and Bridges						
	New Temp Detour 2 Lane Hwy	4,260	LF	175.00	745,500	225,400	970,900
	Demolish Existing 4 Lane Hwy	3,500	LF	50.00	175,000	52,910	227,910
	New Permenant 4 Lane Hwy	3,500	LF	450.00	1,575,000	476,190	2,051,190
0201----	Subtotal: Roads and Bridges						2,495,500
	Contingencies						754,500
0201----	Subtotal: Roads and Bridges						3,250,000
02--	TOTAL: RELOCATIONS						3,780,000
06---	ECOSYSTEM RESTORATION						
	Sediment Delivery via Pipeline						
	Mob & Demob	7	EA	1,600,000.00	11,200,000	3,360,000	14,560,000
	Dredging	28,000,000	CY	2.25	63,000,000	19,410,000	82,410,000
	Subtotal: Sediment Delivery via Pipeline						74,200,000
	Contingencies						22,770,000
	Subtotal: Sediment Delivery via Pipeline						96,970,000
06--	TOTAL: ECOSYSTEM RESTORATION						96,970,000
09--	CHANNELS AND CANALS						
09--	15,000 cfs Diversion						
	Mobilization/Demobilization of Levee Contract	Lump Sum	LS	100,000.00	100,000	30,000	130,000
	Clearing and Grubbing	340	AC	2,500.00	850,000	255,000	1,105,000
	Levee	565,000	CY	6.00	3,390,000	1,013,000	4,403,000
	Fert/Seeding	30	AC	500.00	15,000	4,500	19,500
	Mobilization/Demobilization for Stone Contract	Lump Sum	LS	50,000.00	50,000	15,000	65,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Armor	57,000	TN	25.00	1,425,000	427,500	1,852,500
	Mobilization/Demobilization of Dredge Contract	Lump Sum	LS	750,000.00	750,000	225,000	975,000
	Dredging	4,000,000	CY	3.00	12,000,000	3,600,000	15,600,000
09--	Subtotal: 15,000 cfs Diversion						18,580,000
	Contingencies						5,570,000
09--	Subtotal: 15,000 cfs Diversion						24,150,000
09--	TOTAL: CHANNELS AND CANALS						24,150,000
15--	DIVERSION STRUCTURES						
15--	5,000 cfs Diversion						
	Mob & Demob	2	EA	250,000.00	500,000	150,000	650,000
	Care and Diversion of Water						
	PSA 23 Sheet Pile for Cells	60,600	SF	16.00	969,600	295,400	1,265,000
	Sand for Cells	8,300	CY	8.00	66,400	19,920	86,320
	SPZ 26 Sheet Pile	5,700	SF	18.00	102,600	30,780	133,380
	Dewatering System	Lump Sum	LS	840,000.00	840,000	255,000	1,095,000
	Earthwork for Structure						
	Clearing & Grubbing	5	AC	2,500.00	12,500	3,750	16,250
	Degrading Existing Levee	17,500	CY	3.25	56,875	17,065	73,940
	Rebuild Existing Levee	17,500	CY	6.00	105,000	31,500	136,500
	Seeding & Fertilizing	5	AC	500.00	2,500	750	3,250
	Structural Excavation	73,500	CY	4.00	294,000	89,000	383,000
	Compacted Backfill	23,000	CY	8.00	184,000	55,200	239,200
	Bedding Material	4,800	CY	30.00	144,000	43,200	187,200
	Riprap (dry)	27,000	TONS	50.00	1,350,000	410,000	1,760,000
	Foundation						
	SPZ-22 Steel Sheet Piling	12,200	SF	13.00	158,600	47,580	206,180
	14" x 14" PPC Piling	110,000	LF	30.00	3,300,000	1,005,000	4,305,000
	Reinforced Concrete						
	Base Slab	5,600	CY	250.00	1,400,000	420,000	1,820,000
	Walls & Roof	7,500	CY	425.00	3,187,500	972,500	4,160,000
	Wing Walls	800	CY	400.00	320,000	98,000	418,000
	Unreinforced Concrete						
	Stabilization Slab	1,500	CY	100.00	150,000	46,000	196,000
	Apron	300	CY	100.00	30,000	9,000	39,000
	Special Construction						
	Instrumentation	Lump Sum	LS	40,000.00	40,000	12,000	52,000
	Miscellaneous Metals						
	Embedded Metals	69,300	LBS	2.00	138,600	41,580	180,180

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Gates and Associated Items						
	16'x16' Cast Iron Sluice Gates	5	EA	530,000.00	2,650,000	810,000	3,460,000
	Structural Steel Bulkheads	103,700	LBS	3.00	311,100	93,500	404,600
	Electrical						
	Power & Lighting	Lump Sum	LS	120,000.00	120,000	36,000	156,000
	Emergency Generator	Lump Sum	LS	37,000.00	37,000	11,100	48,100
	Mechanical						
	Operating Machinery	Lump Sum	LS	250,000.00	250,000	75,900	325,900
15--	Subtotal: 15,000 Diversion						16,720,275
	Contingencies						5,079,725
15--	Subtotal: 15,000 Diversion						21,800,000
15--	TOTAL: DIVERSION STRUCTURES						21,800,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				18,338,000	3,667,000	22,005,000
	PED				12,235,000	2,435,000	14,670,000
	E&D				6,895,000	1,320,000	8,215,000
	Monitoring				2,257,000	451,000	2,708,000
30--	Subtotal: Engineering And Design						39,725,000
	Contingencies						7,873,000
30--	TOTAL: ENGINEERING AND DESIGN						47,598,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A):						
	Diversion				5,968,000	1,194,000	7,162,000
	Sediment Delivery via Pipeline				11,636,000	2,327,000	13,963,000
31--	Subtotal: Construction Management						17,604,000
	Contingencies						3,521,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						21,125,000
	TOTAL PROJECT COST						293,962,000

Monitoring the performance of the project features will be conducted as part of the construction portion of the recommended plan. The purpose of including monitoring in the project is to document the performance of the reintroduction in terms of meeting the environmental goals of the project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater diversion volume. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the culverts and minor construction events to maintain the performance of any outfall management measures. Additional actions may be required to maintain the marsh areas created through dedicated dredging. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $120,000.

Table 10 provides a summary of the first costs for this feature.

Table 10. Medium Diversion with Dedicated Dredging at Myrtle Grove Summary of Costs for the LCA Plan (June 2004 Price Level)

Lands and Damages	$	78,990,000
Elements:		
Relocations	$	3,780,000
Ecosystem Restoration	$	96,970,000
Channels and Canals	$	24,150,000
Diversion Structures	$	21,800,000
First Cost	$	225,690,000
Feasibility-Level Decision Document	$	22,005,000
Preconstruction Engineering and Design (PED)	$	14,670,000
Engineering and Design (E&D)	$	8,215,000
Supervision and Administration (S&A)	$	21,125,000
Monitoring	$	2,257,000
Total Cost	**$**	**293,962,000**

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 11**.

Table 11. Medium Diversion with Dedicated Dredging at Myrtle Grove FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 11,002,500	$ 11,002,500	$ 22,005,000
PED (65%Fed-35%NFS)	$ 9,535,500	$ 5,134,500	$ 14,670,000
LERR&D (100% NFS)	$ -	$ 82,770,000	$ 82,770,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 142,920,000	$ -	$ 142,920,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,339,750	$ 1,875,250	$ 8,215,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 16,509,750	$ 4,615,250	$ 21,125,000
Monitoring (65%Fed-35%NFS)	$ 1,467,050	$ 789,950	$ 2,257,000
Total Construction	**$ 176,772,050**	**$ 95,184,950**	**$ 271,957,000**
TOTAL COST	**$ 187,774,550**	**$ 106,187,450**	**$ 293,962,000**
Cash Contribution	*$ 187,774,550*	*$ 12,414,950*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Myrtle Grove diversion and dredging features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two and a half years (April 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule and cost of the design. Preparations of plans and specifications for construction could commence in October 2007 and are forecast for completion in two and a half years (March 2010). Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as April 2010, with construction completion estimated for the end of calendar year 2014.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

The Programmatic Environmental Impact Statement (PEIS) undertaken in the LCA study has assessed the impacts of various restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. These impacts are identified and discussed by specific and cumulative natural and human environmental effects. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

The specific NEPA effort for the proposed Myrtle Grove restoration feature has already been initiated. The public scoping has been completed and documented along with the development of a range of potential alternative plans developed in coordination with the concurrent LCA study effort. As previously discussed, the combined screenings in several previous investigations have consistently identified the proposed feature or a similar range of restoration features.

A NOI to prepare an EIS for the Myrtle Grove Ecosystem Restoration Analysis, Louisiana, was published in the Federal Register on Wednesday, January 30, 2002. Three scoping meetings were originally scheduled (March 13, 2002 - Belle Chasse, Louisiana; March 20, 2002 - Buras, Louisiana; and March 27, 2002 - Jefferson Parish School Board Administration Building, Louisiana). A fourth meeting was held on April 15, 2002 in Belle Chasse at the request of the interested public.

Existing conditions of significant resources likely to be encountered and the occurrence of HTRW within the proposed project area are being investigated by the USACE-MVN. Analysis of future conditions with project (action alternative(s)) will not be initiated until current resource modeling efforts and the selection of action alternatives are concluded. However, coordination with interested local, state, and Federal agencies continues on an as-needed basis until a more detailed plan, other than the no-action (or Future Without Project) alternative is made available.

Uncertainties/Risks

Adaptive Management

The basic components of this restoration feature represent relatively high certainty and low risk. There is a great deal of working experience with marsh creation using dredged sediments (e.g., current beneficial use activities, Labranche wetland restoration, etc.) as well as for influencing wetland restoration using river diversions (e.g., Naomi Siphon, Caernarvon, Davis Pond, etc.). However, the combination of these two components is particularly suited for application of adaptive management. The response of the marsh platform and operation of the diversion can then be monitored and adjusted to optimize wetland building. Variations can be measured against constructed and natural marsh platform parameters, level and frequency of diversion operation, timing of diversion, and distance from the diversion. These are applications exportable to any location where river diversions might be applied with or without mechanical wetland creation, or where marsh creation might be utilized in the presence of some amount of riverine influence.

Subject to Feasibility

The major area of uncertainty in this restoration feature is the combining of the proposed diversion and its operation with other existing diversions and their combined effect on the Barataria Basin as a whole. The detailed study of these hydrologic effects, the combined operational consideration, and the resulting ecological response is a necessary product of the final decision document for this feature. The identification of secondary socio-economic effects, if any, for private and commercial development in the immediate area is also a significant question with implications to the rest of the LCA restoration effort.

Contingent Authorization/Demos/S&T

The combination of direct creation of wetlands and river diversion also allows variations in the specifications of the dredge material placement as a demonstration. Just as the combination of these two restoration techniques is conducive to adaptive management, initial variations in the placement of dredged material could produce additional insight for future wetland construction. The vegetative response of various created wetland platforms could aid in identifying the minimum and optimum material placement requirements when additional inputs of sediment are available. This would allow for maximum use of available sediment resources and also be applicable in certain beneficial use applications.

Recommendations/Summary

The Medium Diversion with Dedicated Dredging at Myrtle Grove restoration feature addresses critical ecological needs in a sensitive area of the most highly productive estuarine systems in the Nation. The components of the feature create a synergy that will result in highly productive and sustainable outputs. The design and operation of the feature will maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature will also support opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration measures and/or adaptive management.

The level of investigation in this area undertaken to date provides a high level of certainty in the appropriateness of the restoration feature and the range of alternative configurations that should be addressed in a final decision document. These previous investigations have also provided enough technical insight to provide confidence in the relative costs and potential benefits of the feature. These parameters will be refined along with the specific feature design for final consideration for implementation. The current status of analyses and NEPA documentation also provide a high degree of confidence that the design and documentation for this restoration feature can be completed for approval and implementation on an expedited schedule.

For these reasons, the Medium Diversion with Dedicated Dredging at Myrtle Grove feature has been recommended for contingent authorization. The execution of this restoration feature constitutes an element of the most appropriate near-term action for achieving the restoration of coastal Louisiana.